Clinical Olfactory Event-Related Potentials

Manual for data analysis

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To download:

- Letswave software to analyze EEG data in MatLab

https://nocions.github.io/letswave6/

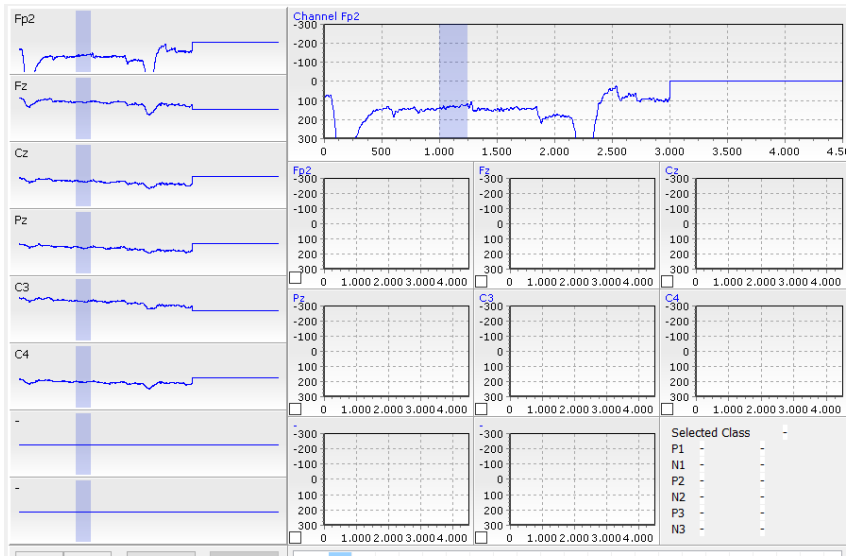
- Letswave scripts with the analysis pipeline
  - Script 1 – for event-related potentials
  - Script 2 – for time-frequency analysis
- Template to report results in .pptx

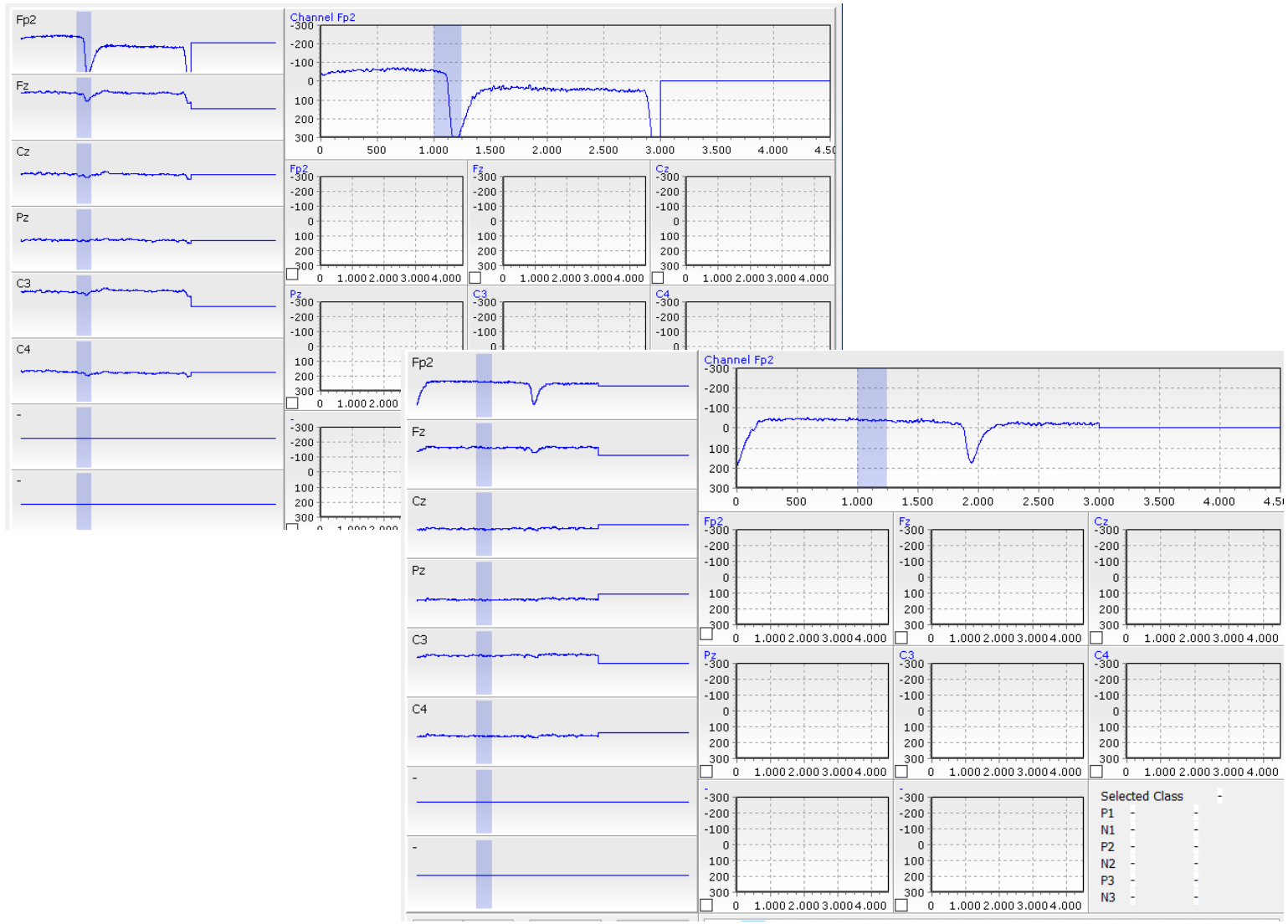
https://osf.io/5za3y/?view_only=6998f2aa50ea4e27ac5a8f3e75d6cf1c

1. Epochs selection

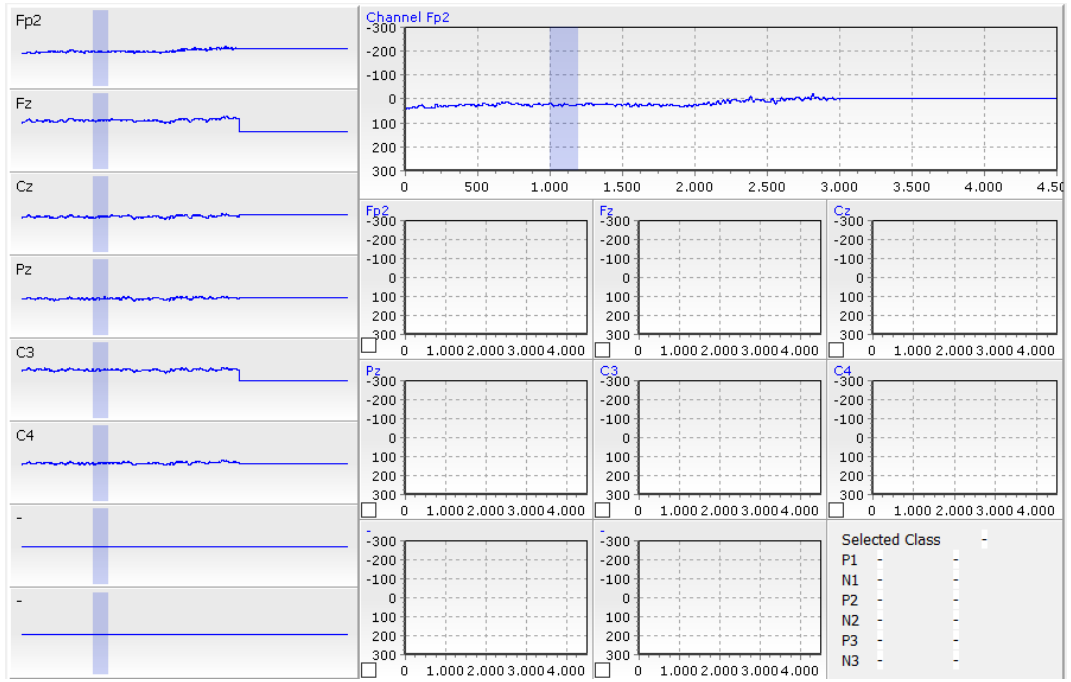
- Each recorded epoch needs to be visually inspected for potential eye-blinks or other types of artifacts.
- Epochs containing artifacts should not be included in the analysis.
- Final number of epochs used for analysis should be recorded.

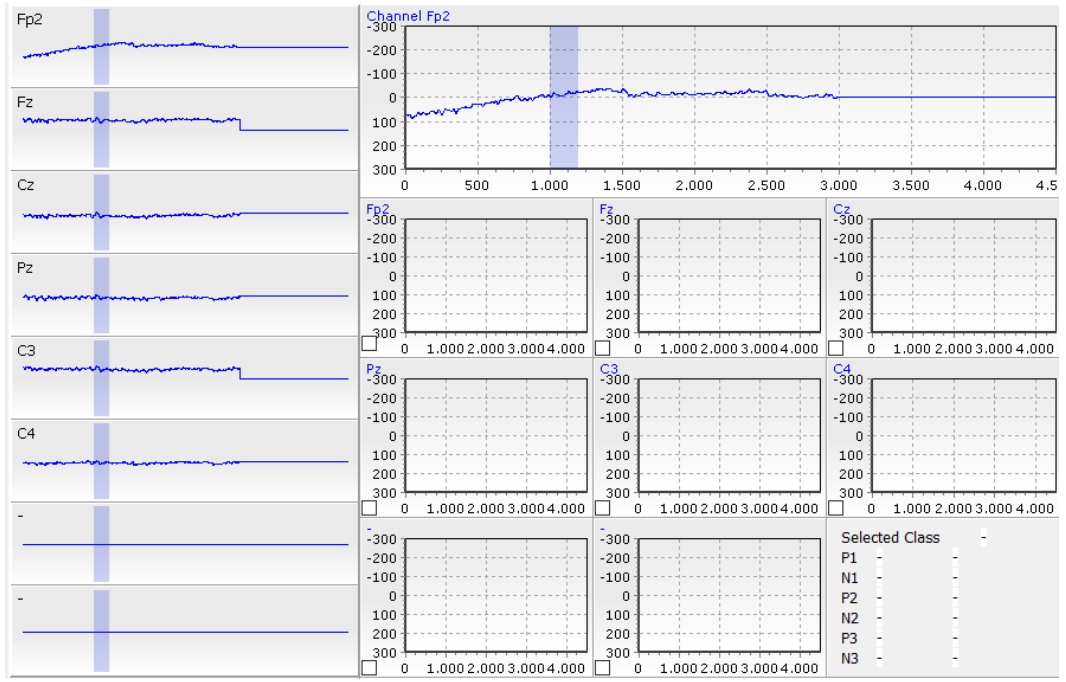
Examples of artifacts / eye-blinks (to be excluded)





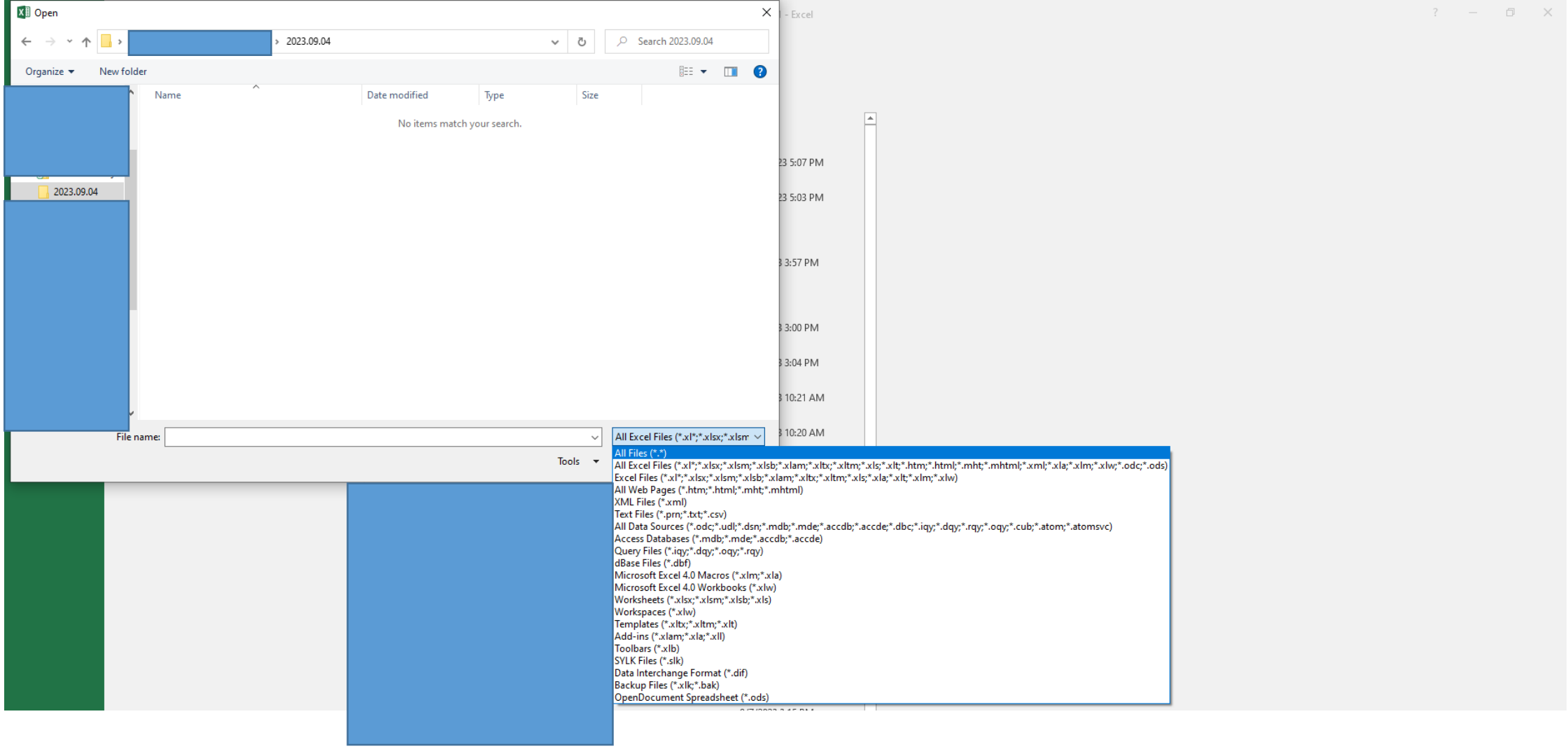
Examples of artifact-free signal (good for analysis)



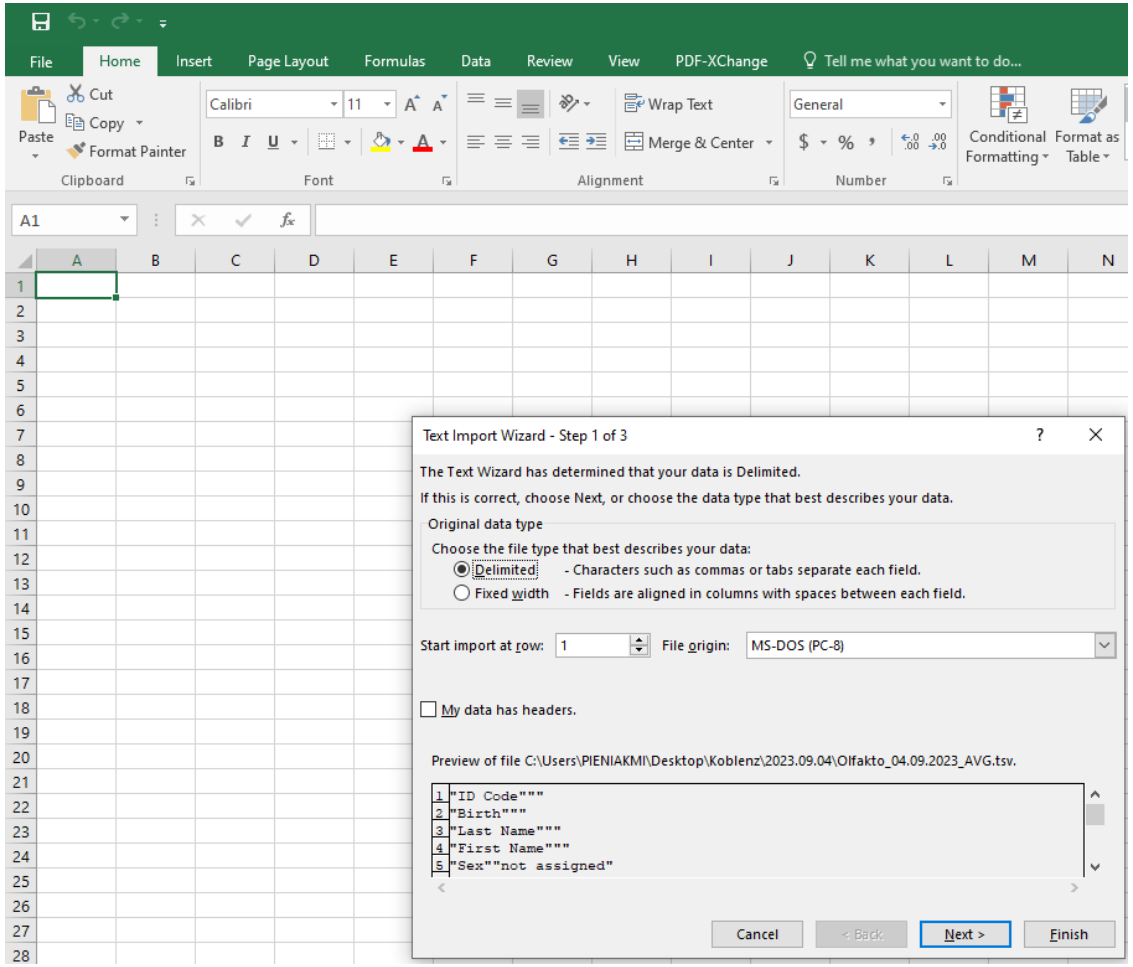


2. Preparing the dataset for analysis

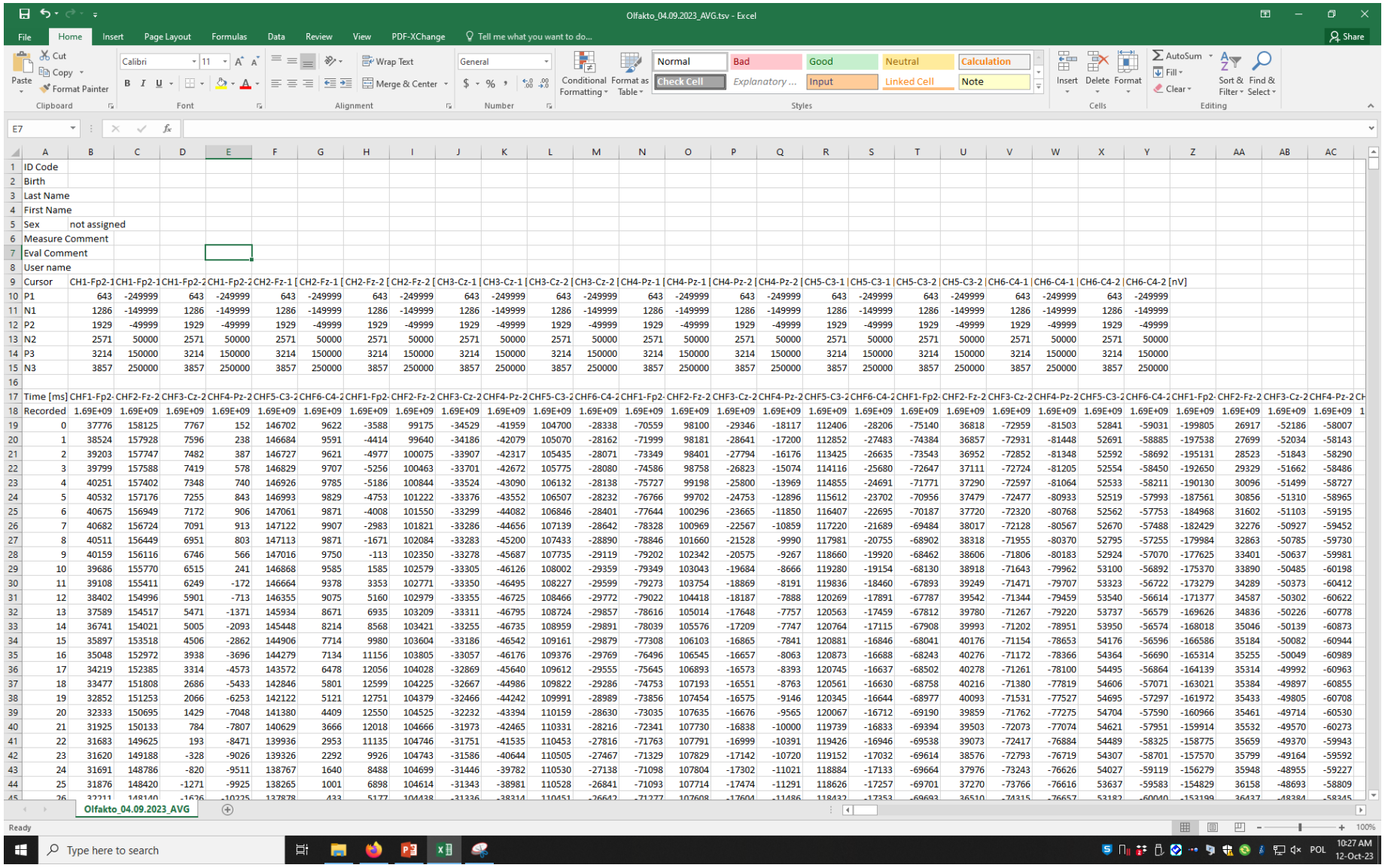
- The original dataset is saved in .tsv file.
- First the dataset should be open in Excel for cleaning



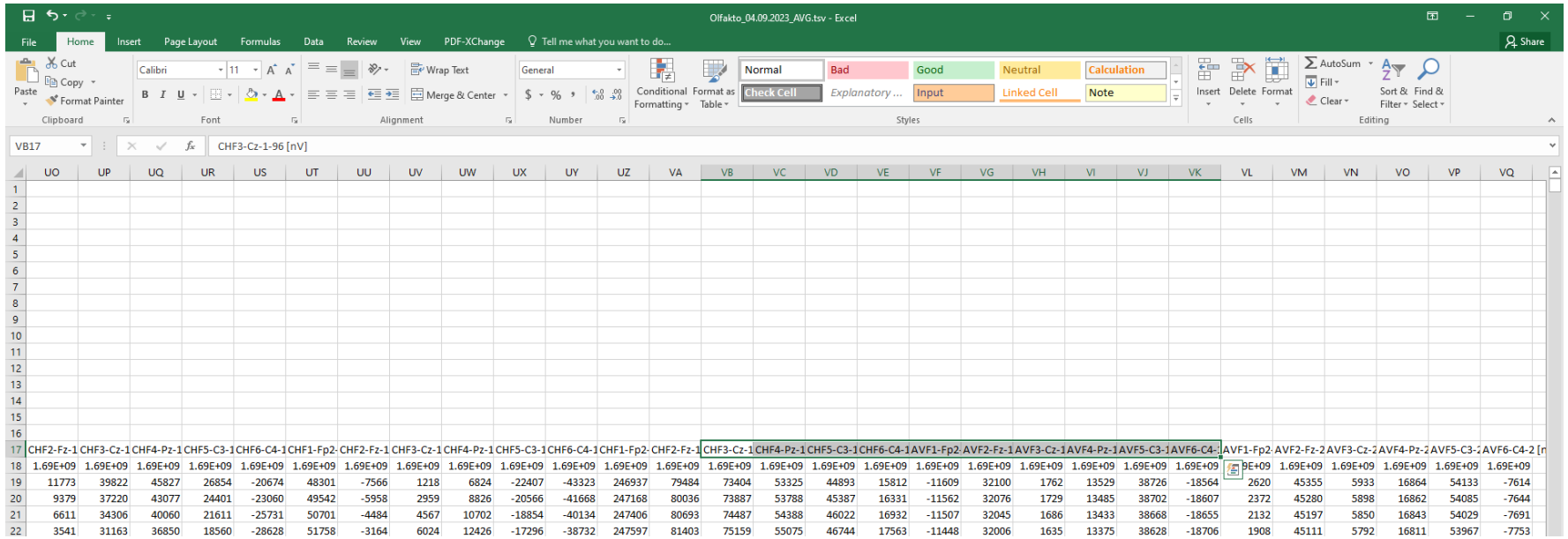
- To find .tsv files – select All files



- Click Finish

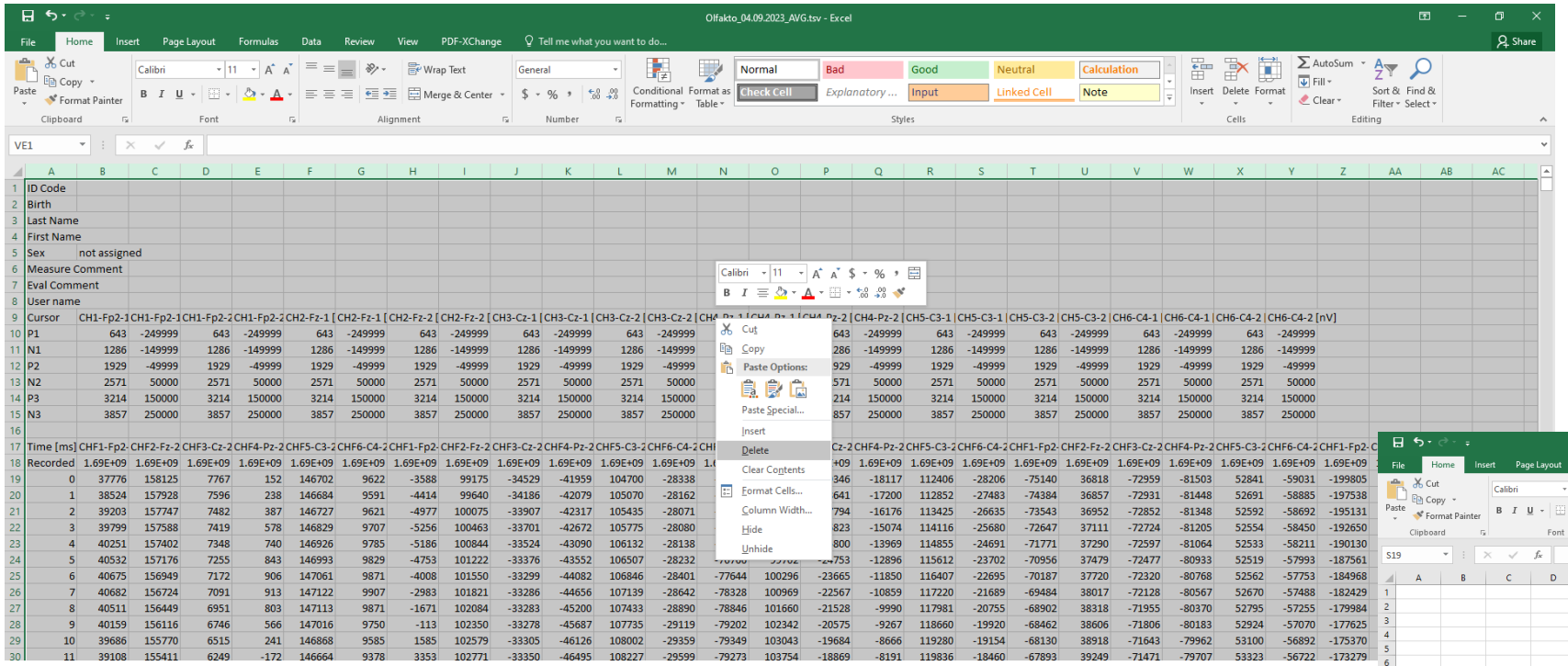


- This is the default view of the dataset. In the first rows it contains Participants data. Further, each row is represents 1ms of the EEG signal and columnd represent signal at different electrodes for different stimuli.



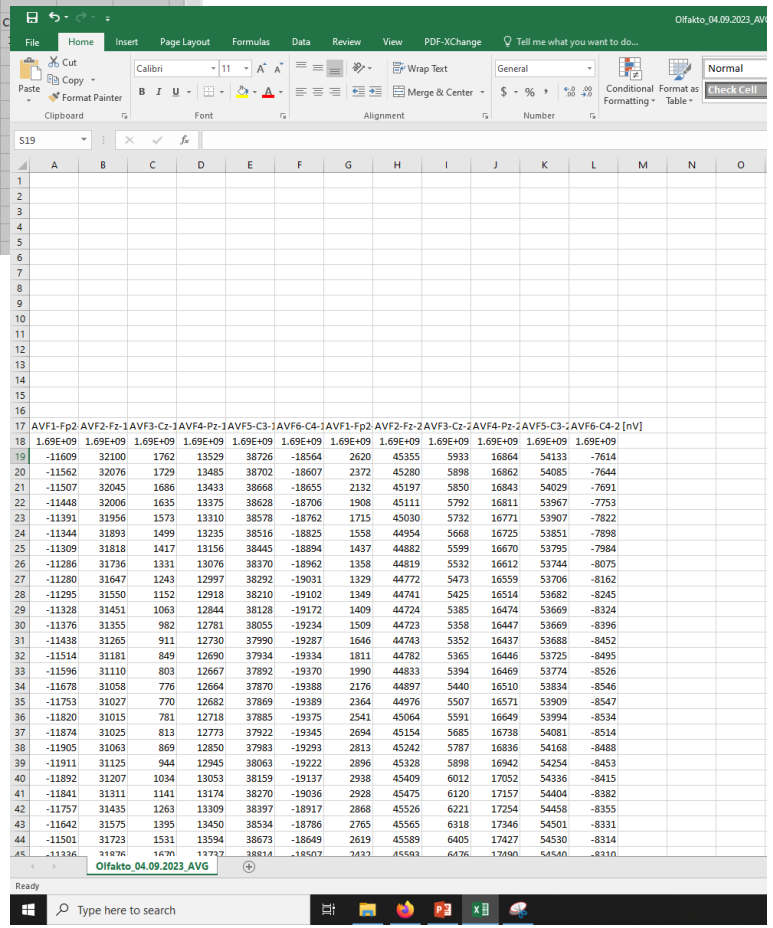
CHF2-Fz-1	CHF3-Cz-1	CHF4-Pz-1	CHF5-C3-1	CHF6-C4-1	CHF1-Fp2	CHF2-Fz-1	CHF3-Cz-1	CHF4-Pz-1	CHF5-C3-1	CHF6-C4-1	CHF1-Fp2	CHF2-Fz-1	CHF3-Cz-1	CHF4-Pz-1	CHF5-C3-1	CHF6-C4-1	AVF1-Fp2	AVF2-Fz-1	AVF3-Cz-1	AVF4-Pz-1	AVF5-C3-1	AVF6-C4-1	AVF1-Fp2	AVF2-Fz-2	AVF3-Cz-2	AVF4-Pz-2	AVF5-C3-2	AVF6-C4-2 [n
1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	9E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09
11773	39822	45827	26854	-20674	48301	-7566	1218	6824	-22407	-43323	246937	79484	73404	53325	44893	15812	-11609	32100	1762	13529	38726	-18564	2620	45355	5933	16864	54133	-7614
9379	37220	43077	24401	-23060	49542	-5958	2959	8826	-20566	-41668	247168	80036	73887	53788	45387	16331	-11562	32076	1729	13485	38702	-18607	2372	45280	5898	16862	54085	-7644
6611	34306	40060	21611	-25731	50701	-4484	4567	10702	-18854	-40134	247406	80693	74487	54388	46022	16932	-11507	32045	1686	13433	38668	-18655	2132	45197	5850	16843	54029	-7691
3541	31163	36850	18560	-28628	51758	-3164	6024	12426	-17296	-38732	247597	81403	75159	55075	46744	17563	-11448	32006	1635	13375	38628	-18706	1908	45111	5792	16811	53967	-7753

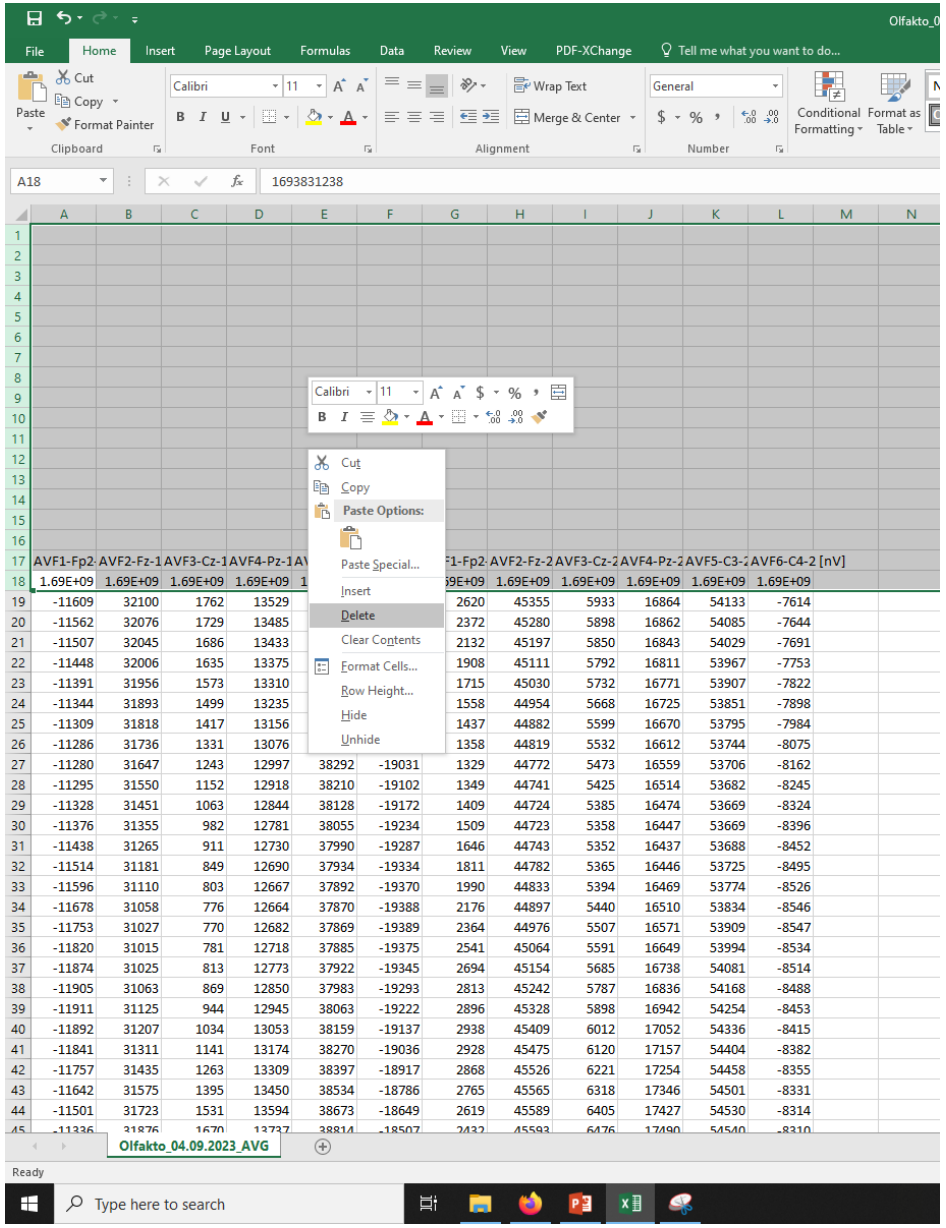
- In the last colums, the labels are starting with AVF and not CHF. The AVF columns represent the averaged signal from the 6 locations (Fp2, Fz, Cz, Pz, C3, C4) for the two stimuli (in total 12 columns).
- We want to keep only the AVF columns.



- Select all columns except the AVF columns and delete them

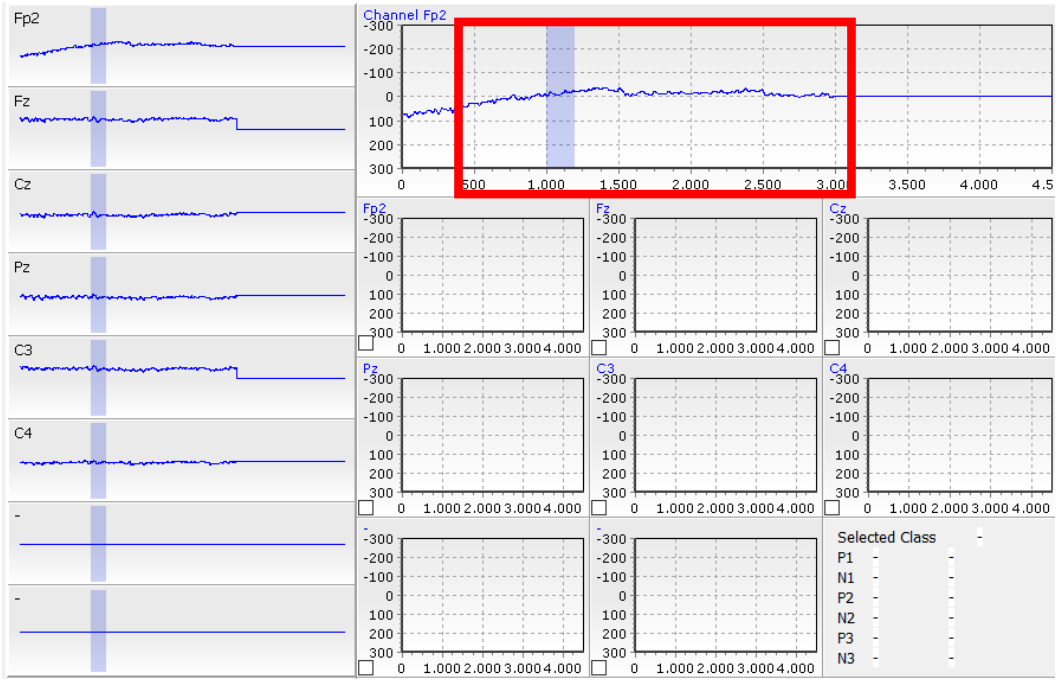
Afterwards the dataset should look like that →

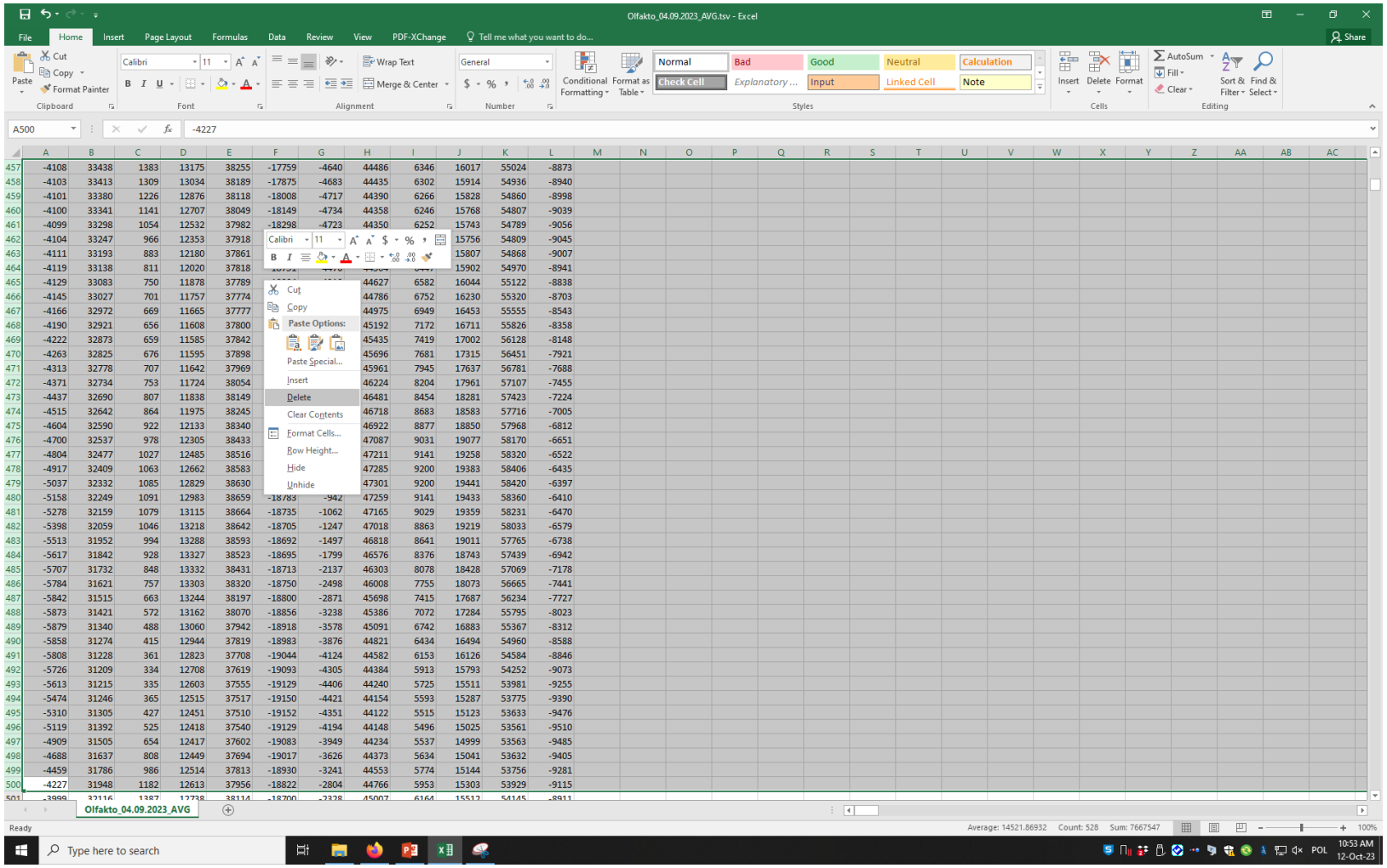




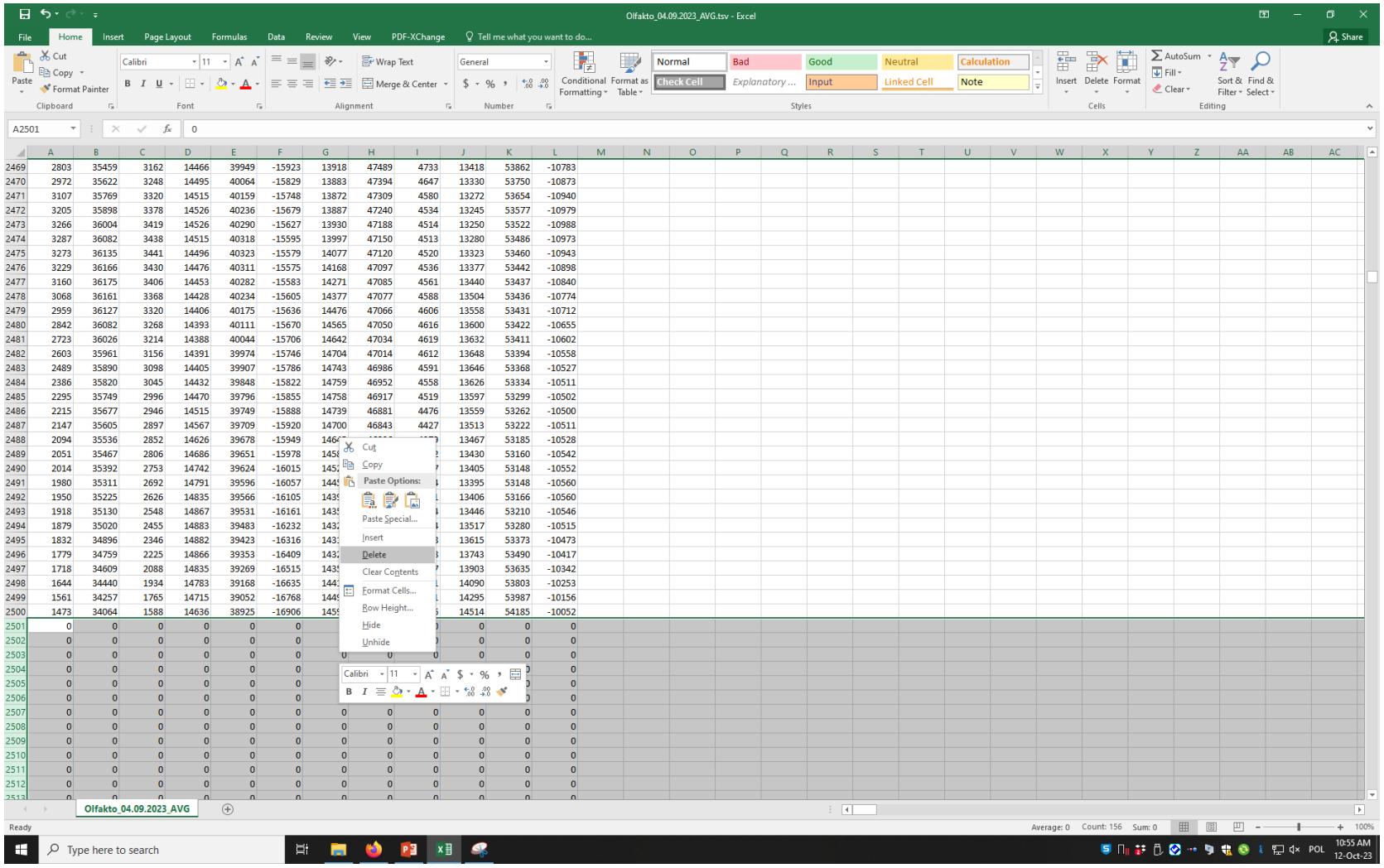
- We now remove the first row (inluding headers) so only the raw data stays in the file

- Now, we have all the raw data, but for the analysis we want to keep only 500 ms before the stimulus onset and 2000 ms after the simulus onset. All the remaining data should be removed.
- How much data should be removed depends on your olfactometer and amplifier settings (some hardware records 1000 ms before the onset, some more; that's the same for the recording afterwards)
- In the example below - first 500 ms and all the signal after 2000 ms post stimulus onset should be removed





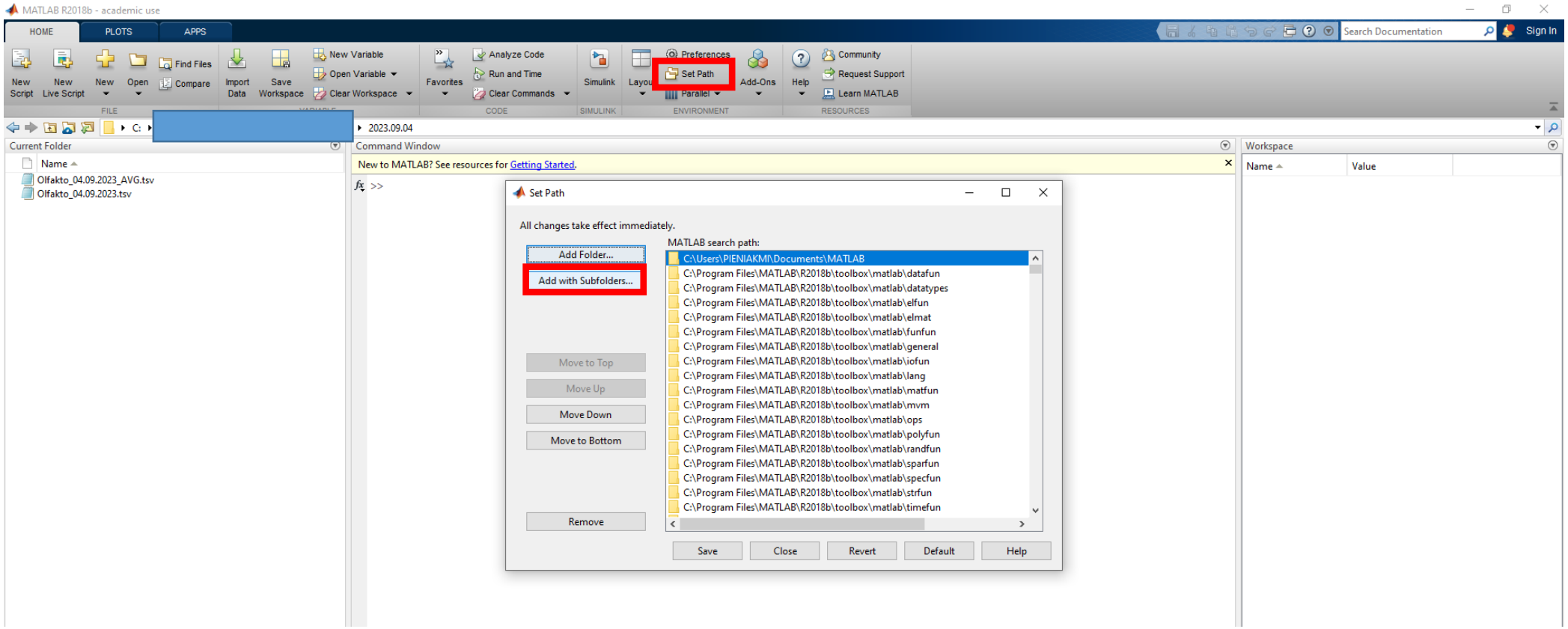
- Remove the first 500ms by marking the row A500 and using the combination Ctrl+Shift+Arrow Up



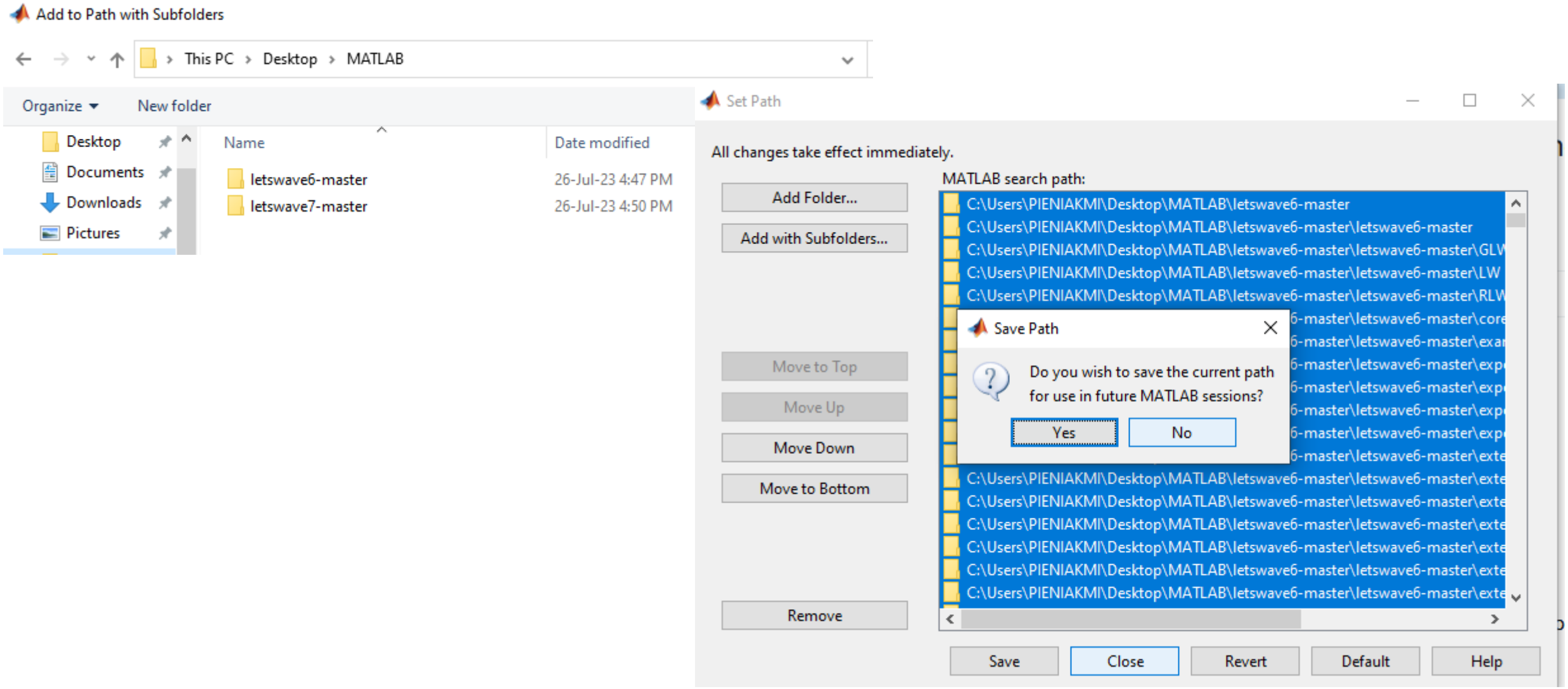
- Remove everything after 2500ms of the signal of interest (A2500) by using the combination Ctrl+Shift+Arrow Down (go to the end of the file)

3. Preprocessing in Matlab

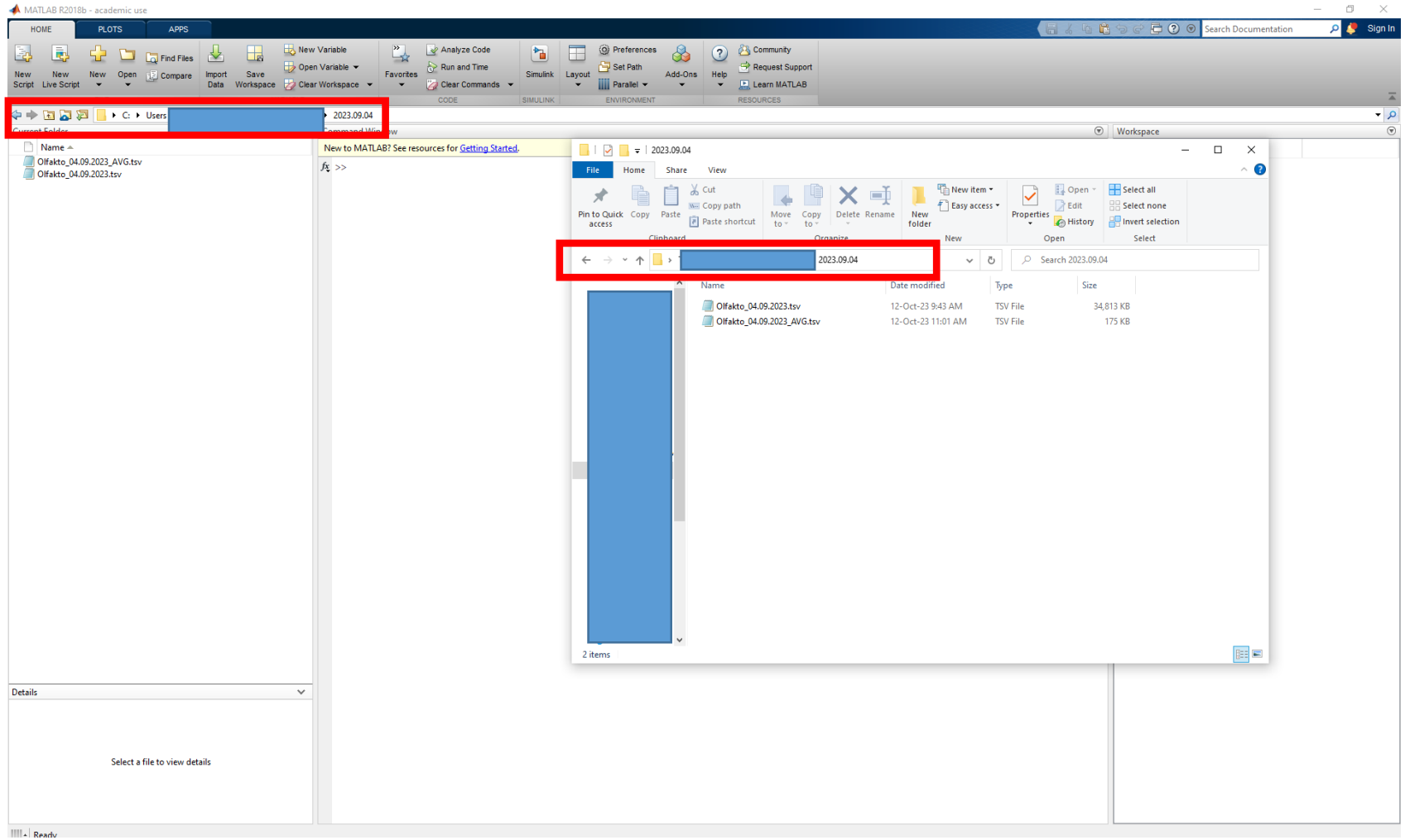
- For preprocessing we use Letswave program (ver. 6)
- To use letswave you need to set a path to the folder with the program



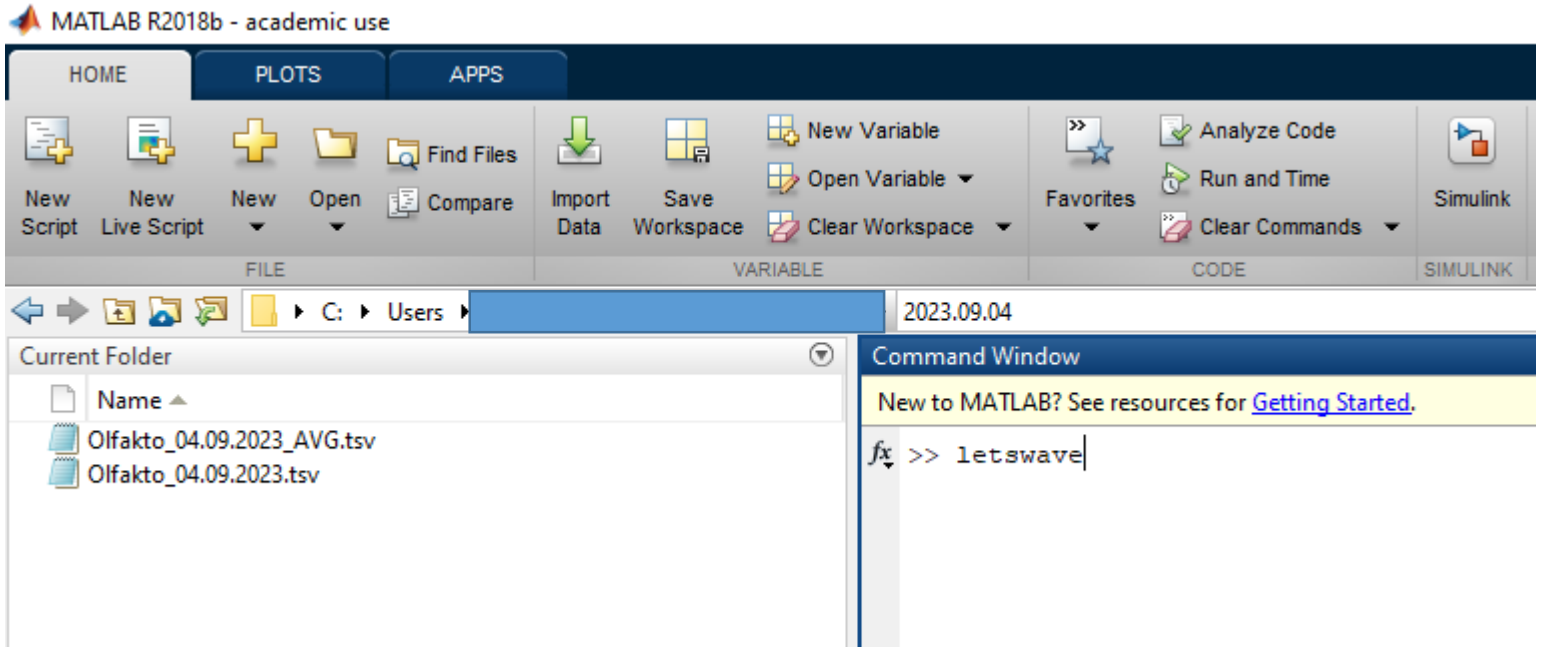
Select letswave6, close the window and do not save the path for future MATLAB sessions



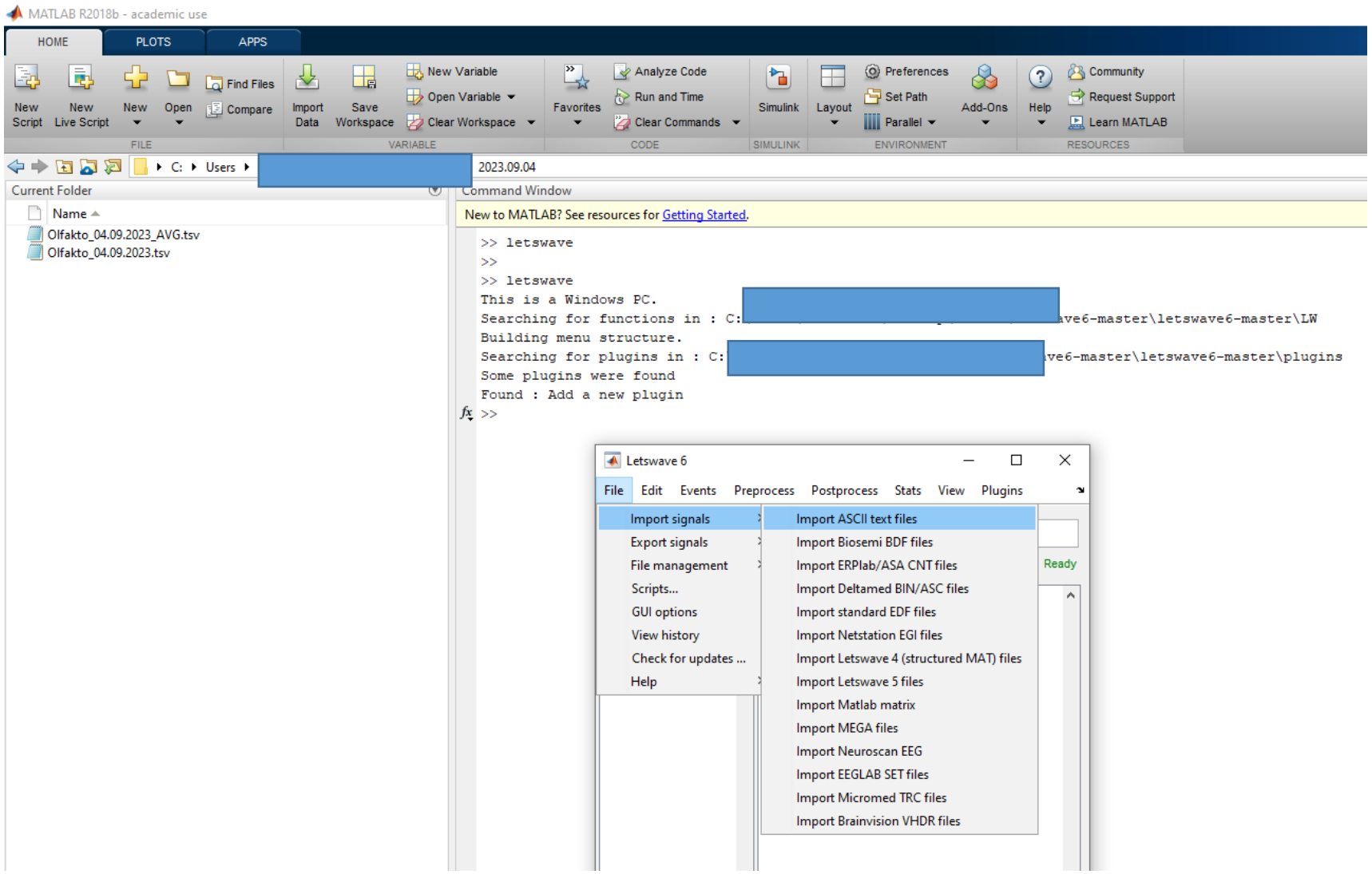
Make sure that Matlab file location matches the folder where your dataset is stored



Use command >letswave to open the program

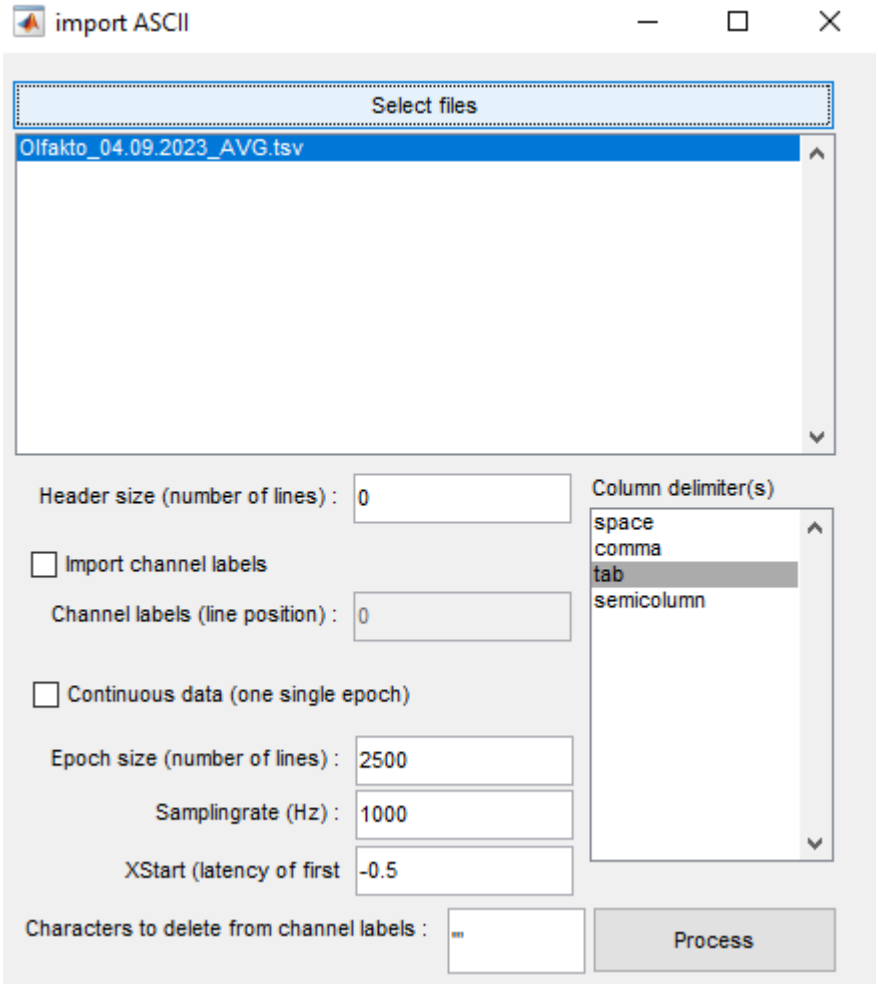


Import the data to letswave using the following path

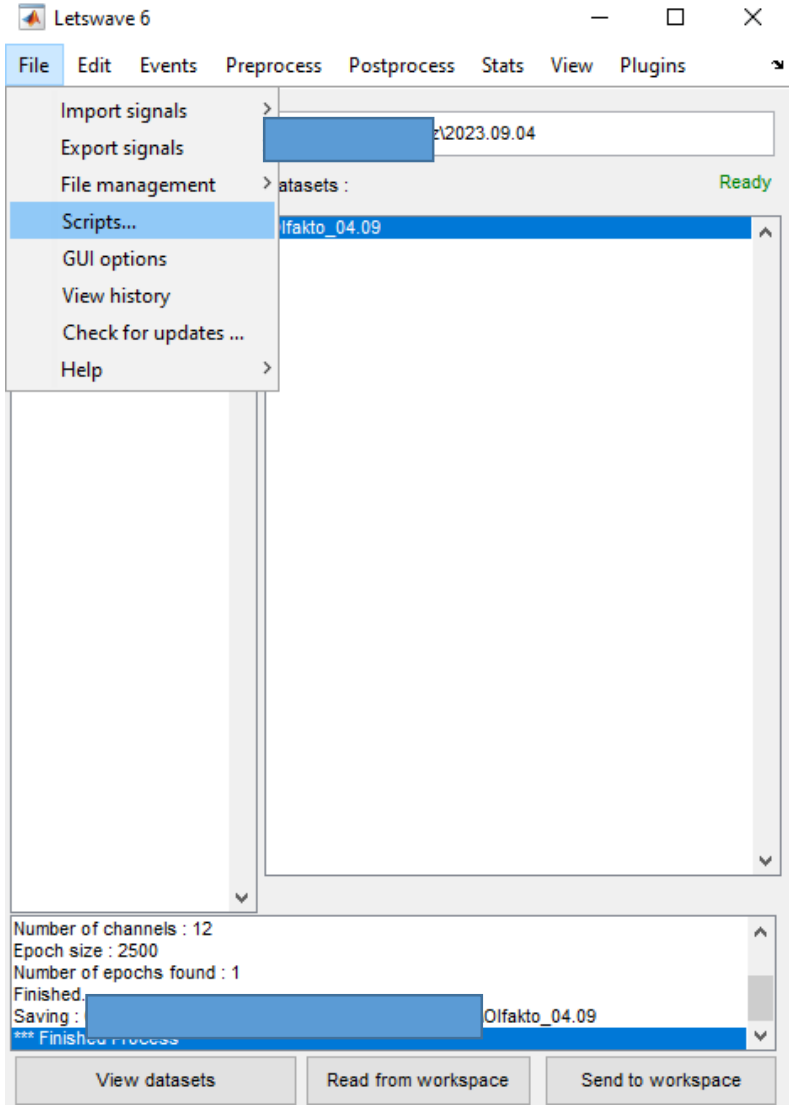


Select your clear .tsv file, choose tab column delimiter and change epoch size to 2500 (default is 1000). Click Process

Note: sometimes an error occurs at this stage, then you need to reload letswave again

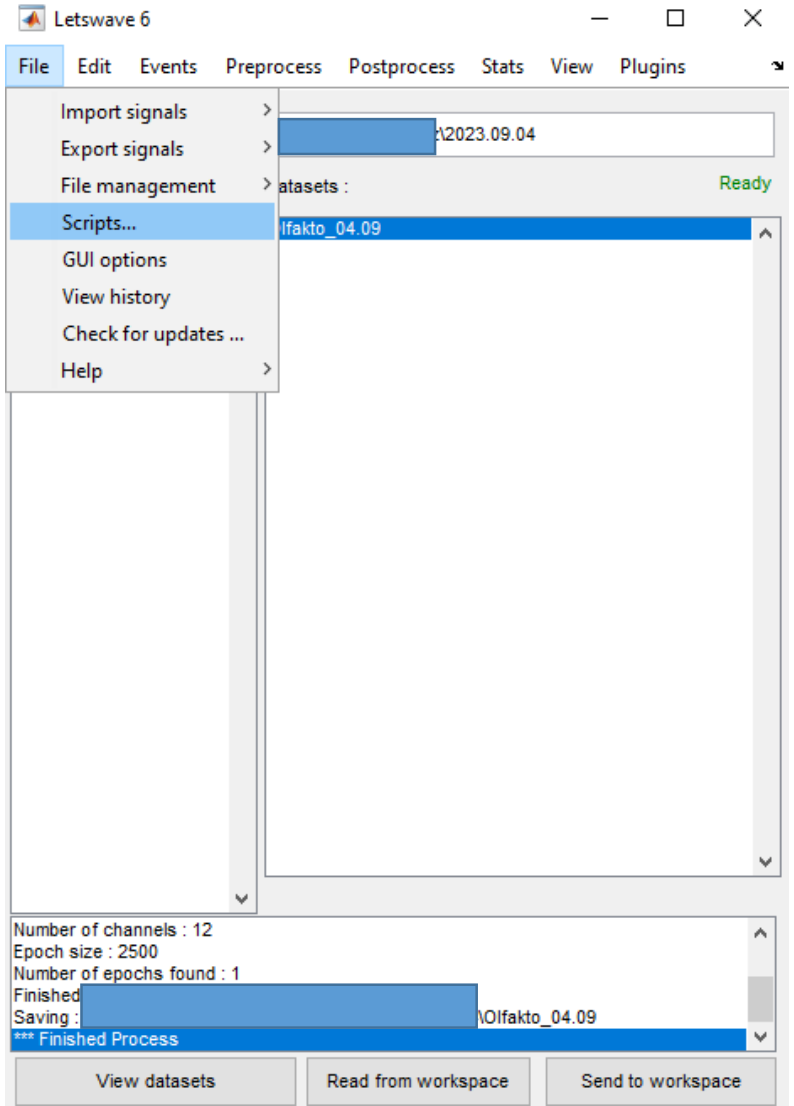


We have two scripts prepared: 1. for averaging the signal and 2. time-frequency analysis



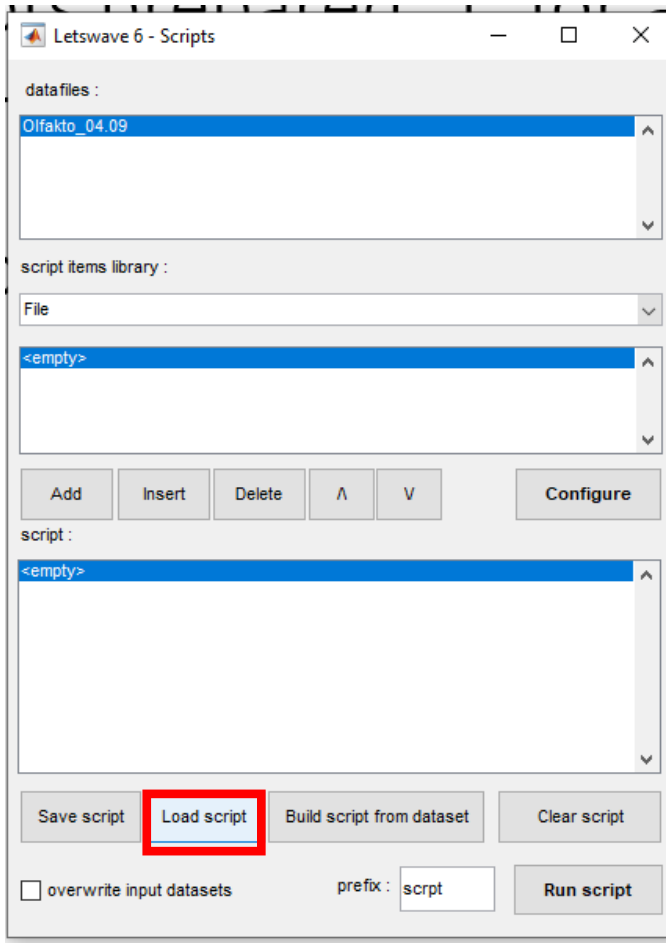
To use them, open File → Scripts

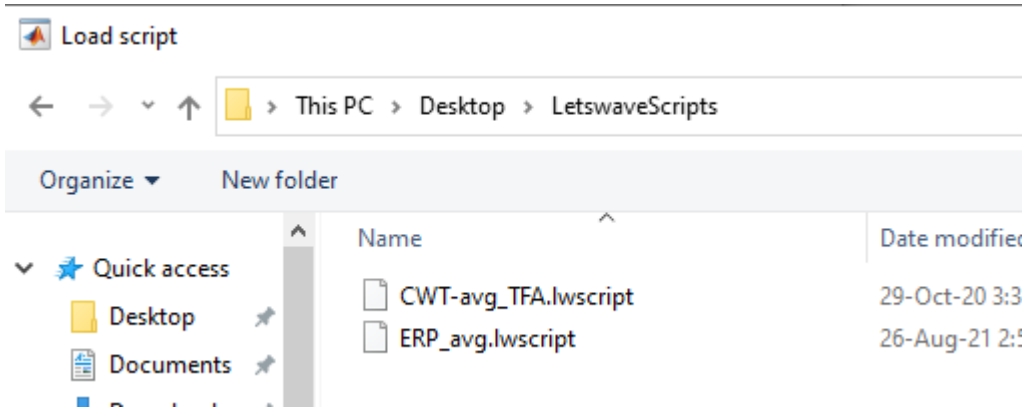
We have two scripts prepared: 1. for averaging the signal and 2. time-frequency analysis

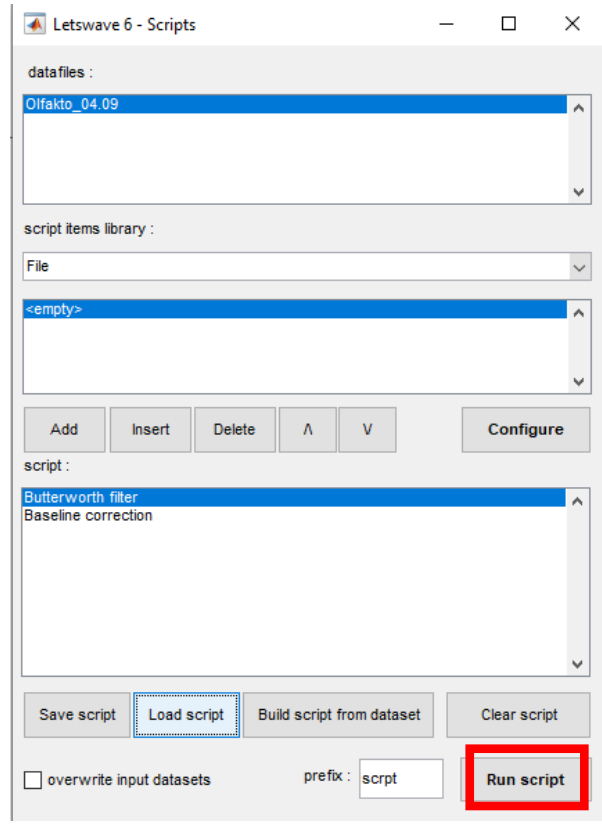


To use them, open File → Scripts

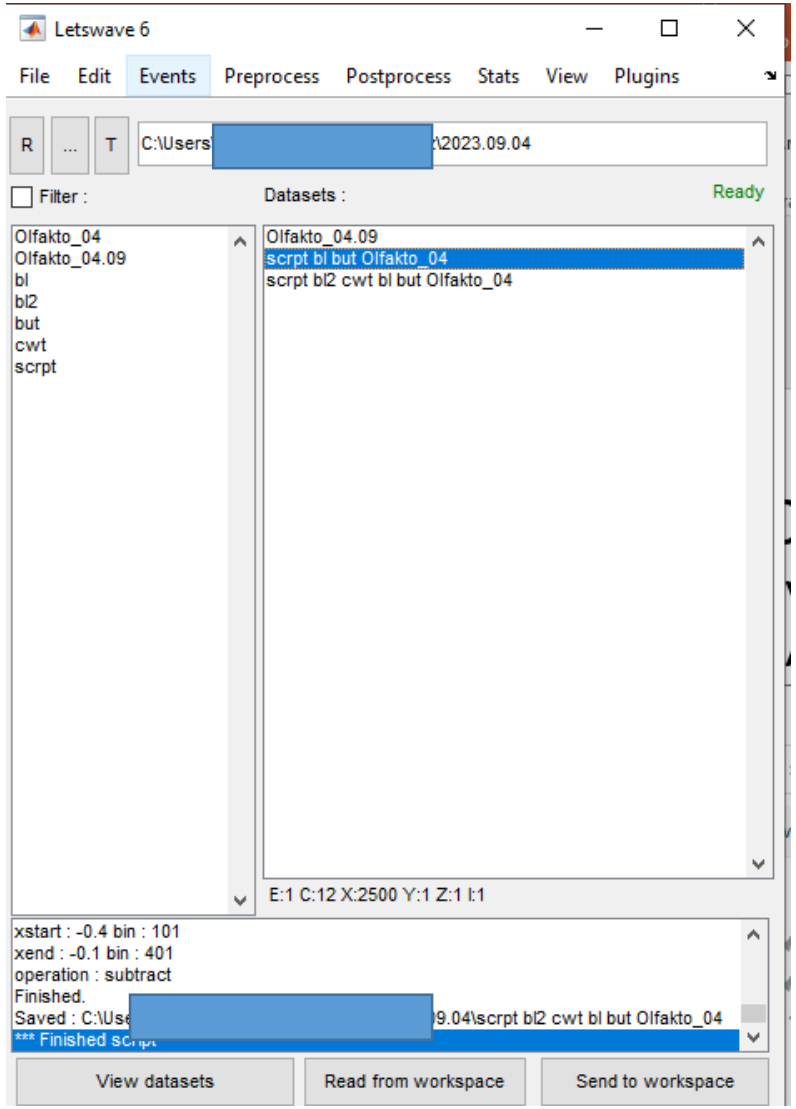
Load and run script (each script needs to be loaded separately)







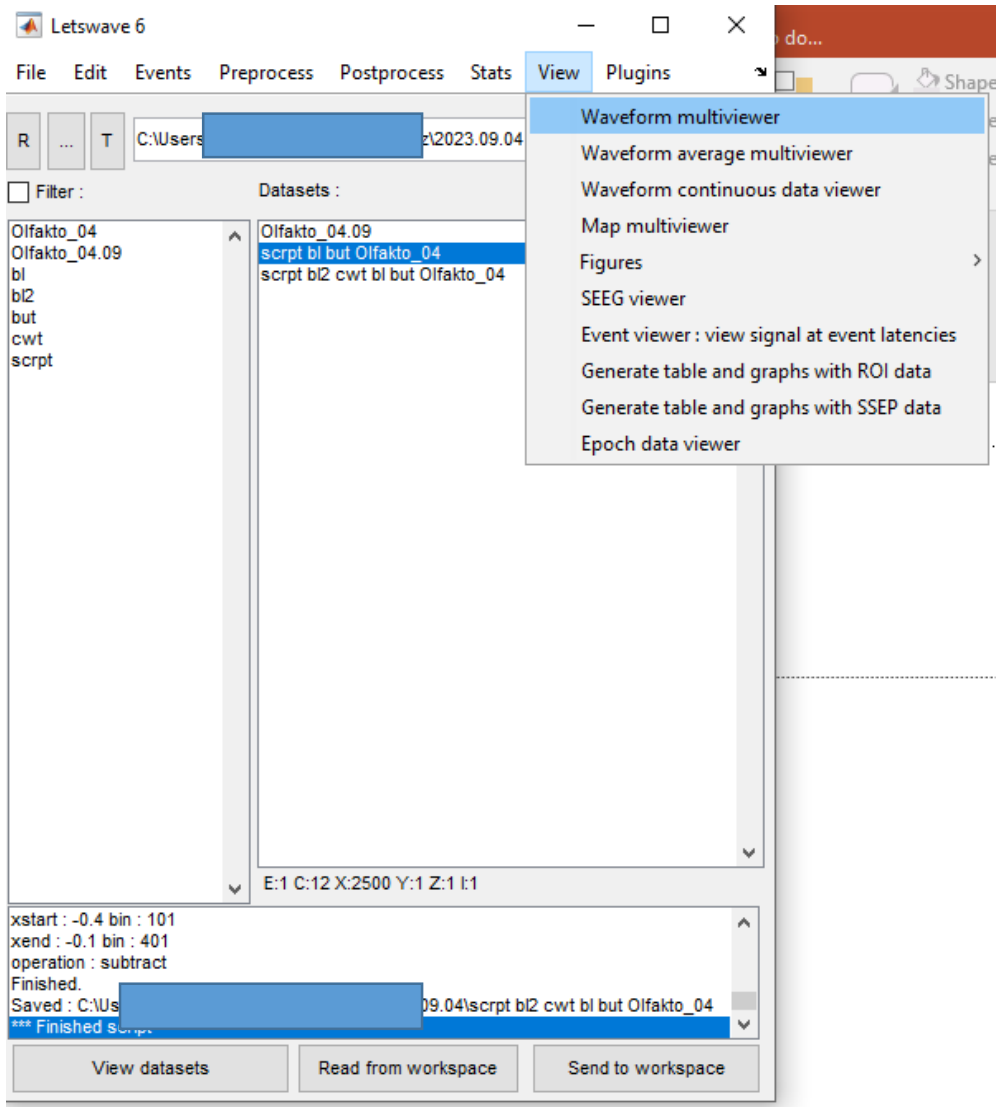
There are two new files in the workspave



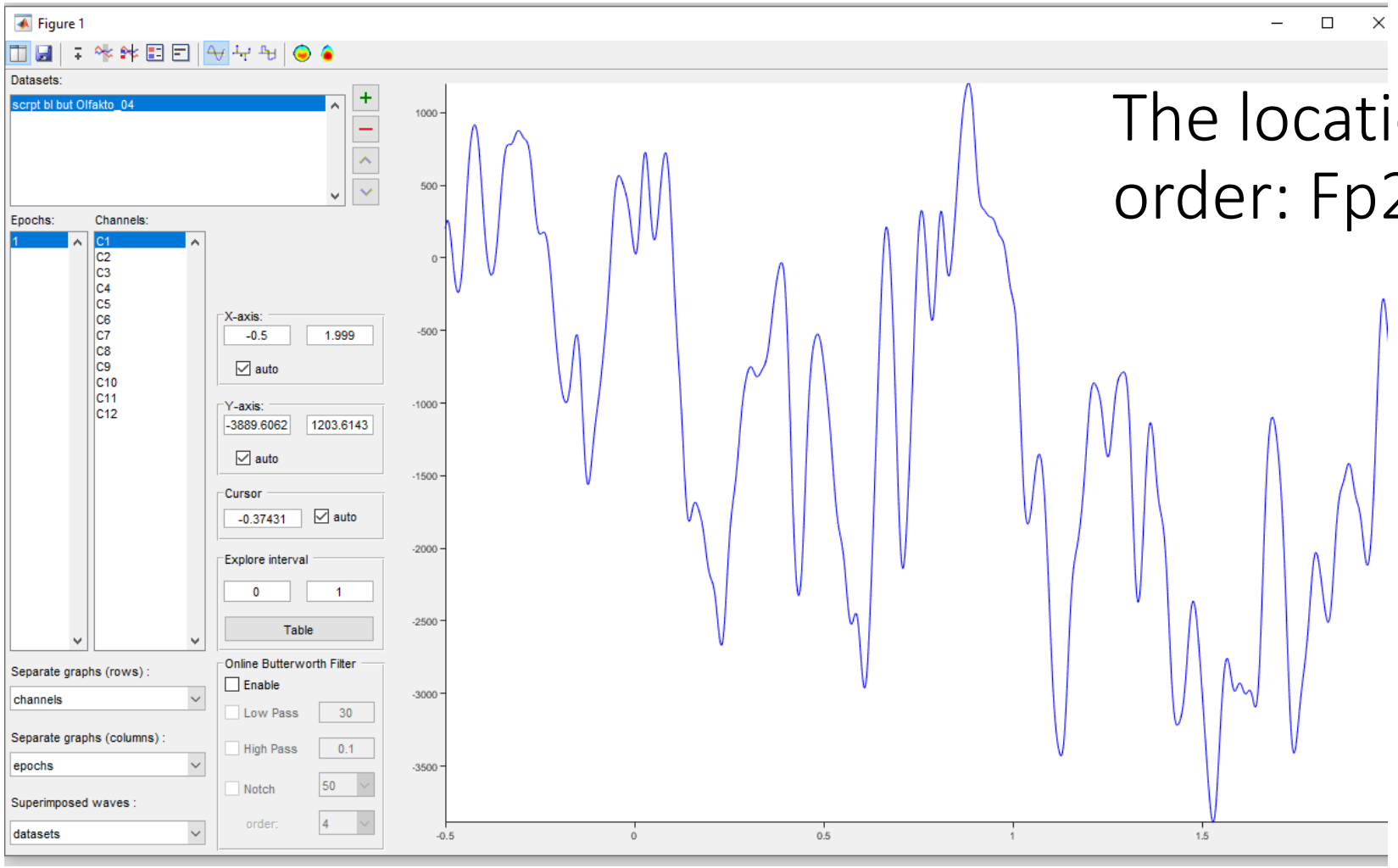
Scrpt bl but → for averaged OERPs

Scrpt bl2 cwt bl but → for time-frequency analysis

For OERPs → View -> Waveform multiviewer

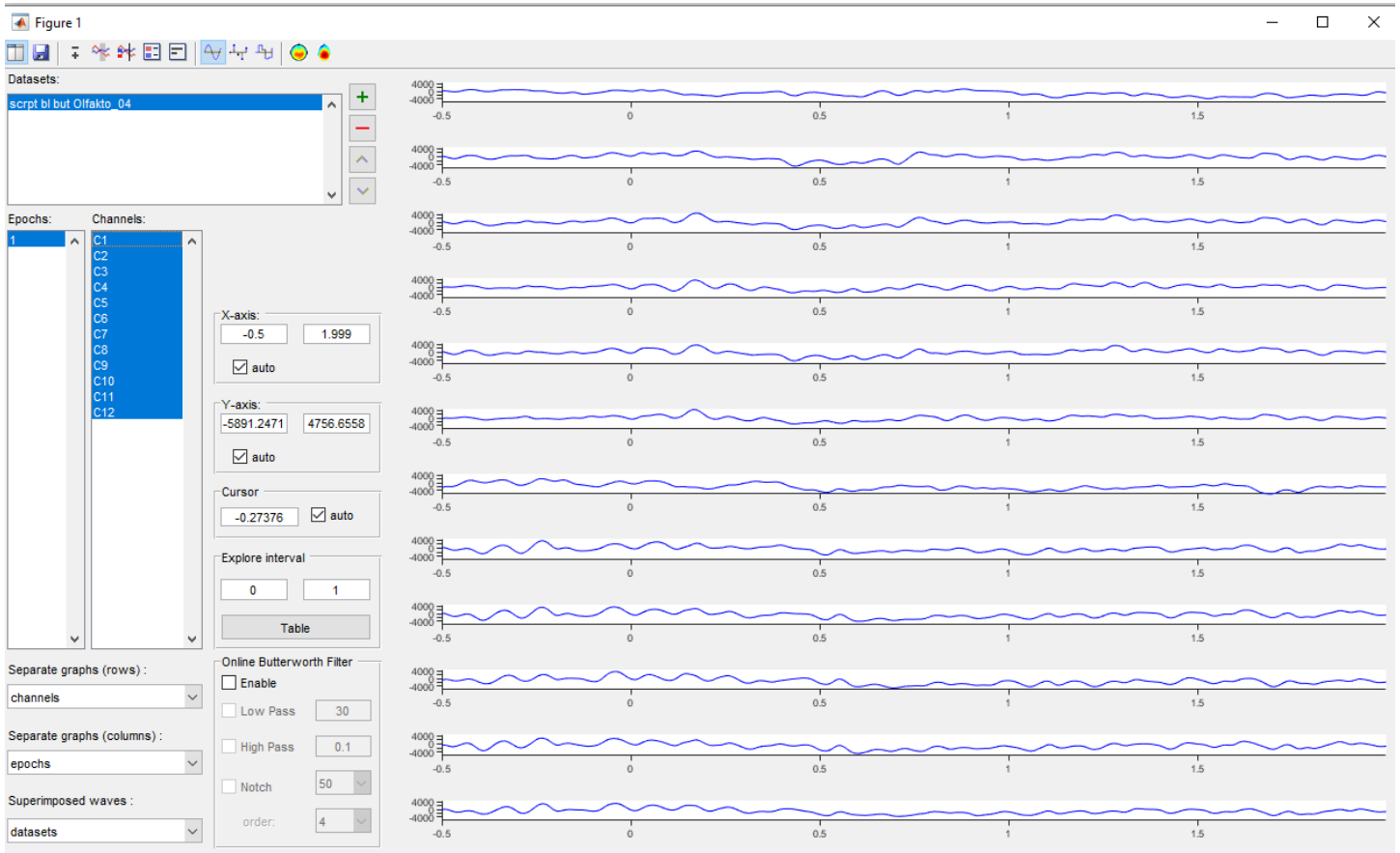


All the averages are visible now. There are 12 channels. First 6 channels are for Stimulus 1, channels 7-12 are for Stimulus 2.



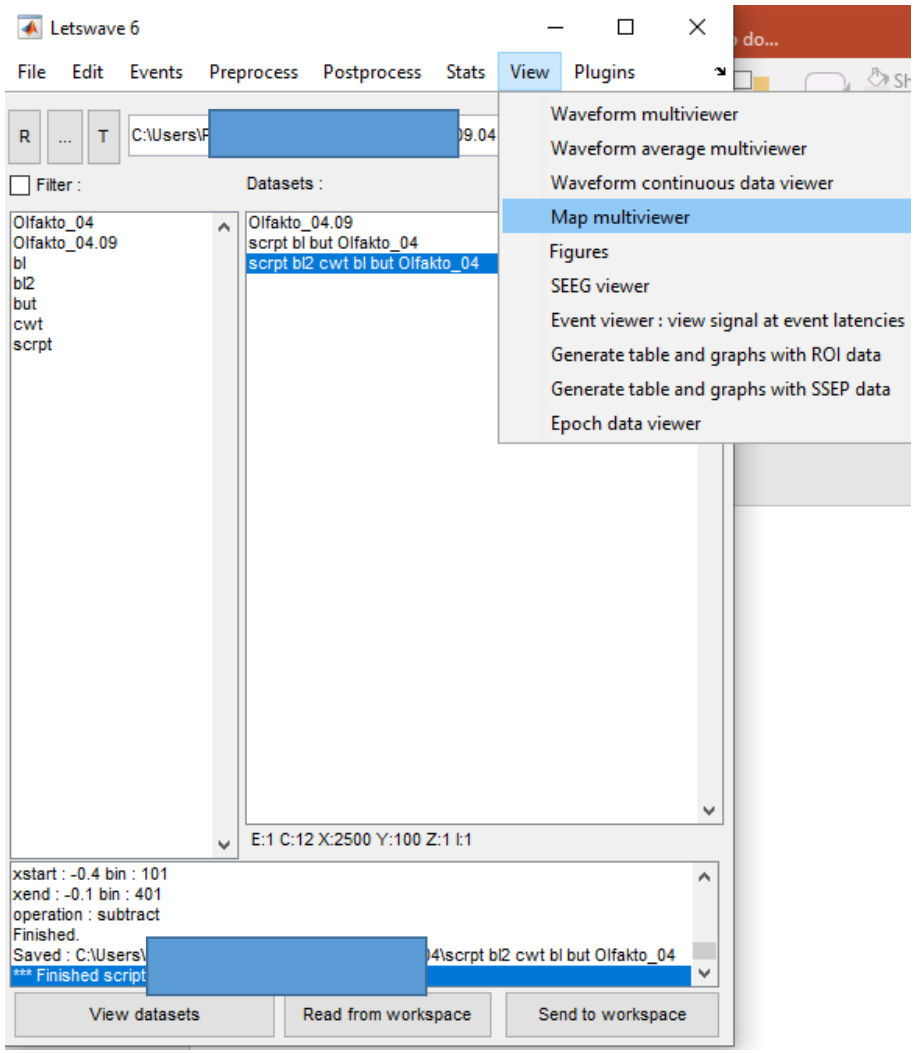
The locations are in the following order: Fp2, Fz, Cz, Pz, C3, C4

Select all the channels and set the Y-axis range to the same value for all of them



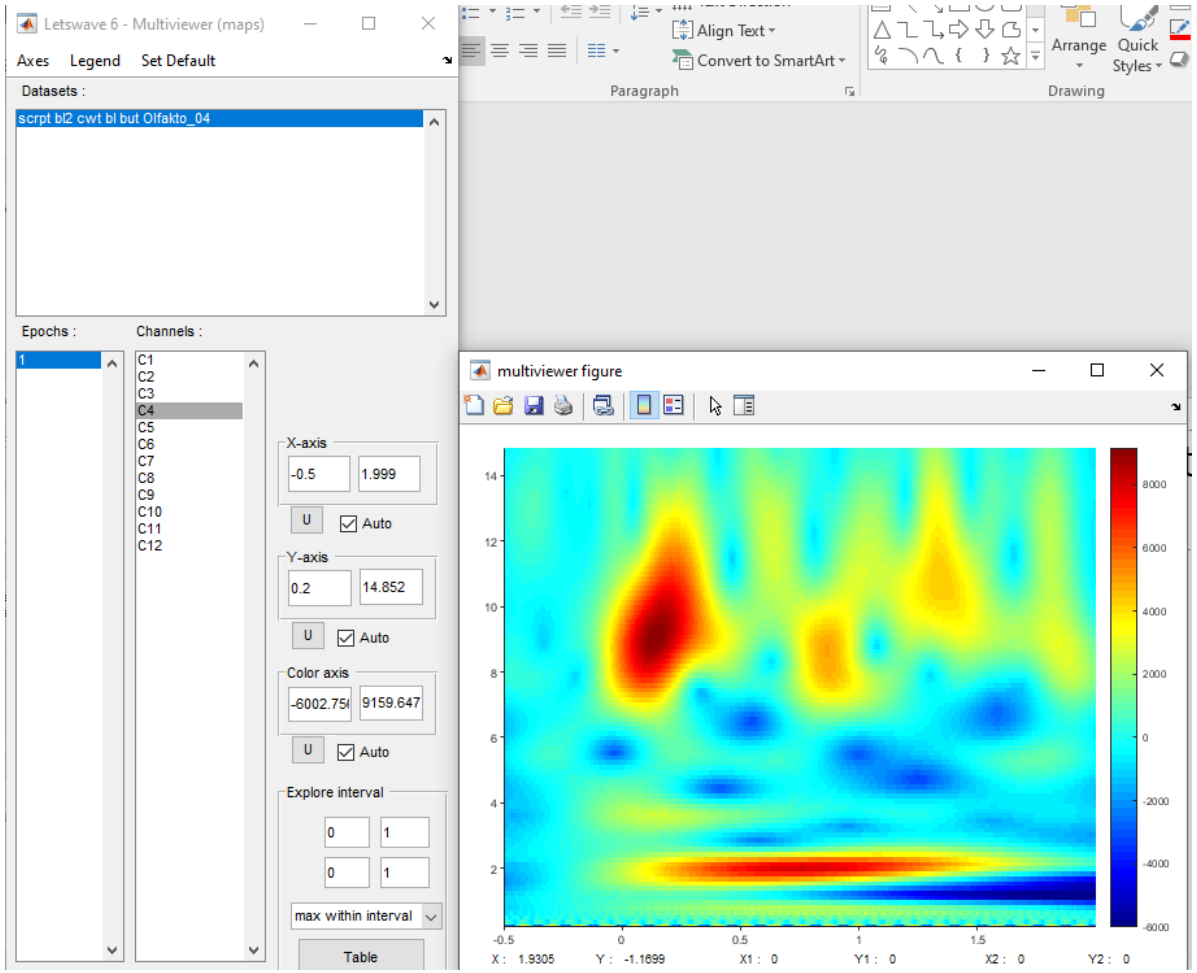
Now each of the OERPs might be saved for the final report (we use the Snipping tool and paste the images into the template)

To view the time-frequency maps: View: Map multiviewer

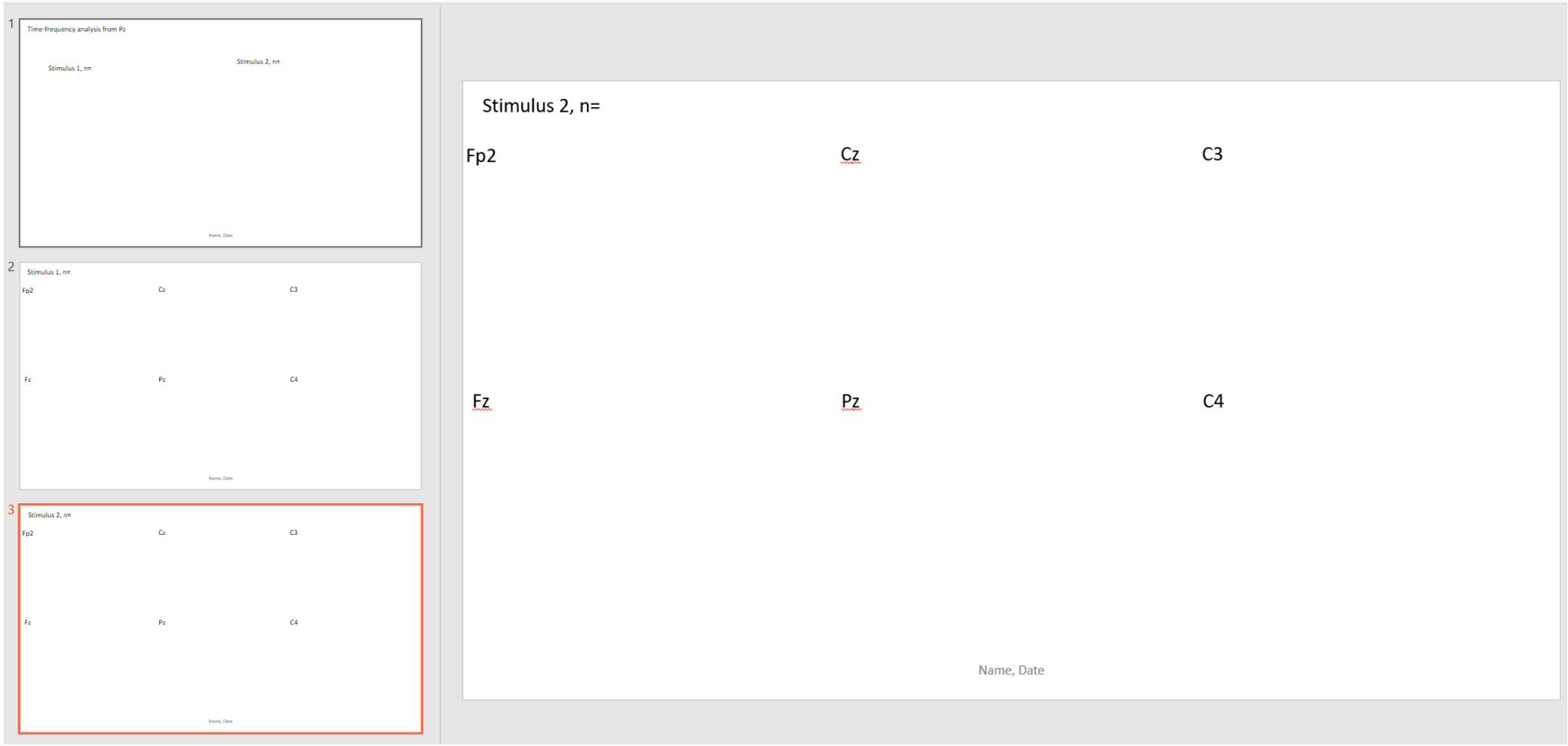


TFA we do for Pz location. These are channels 4 and 10.

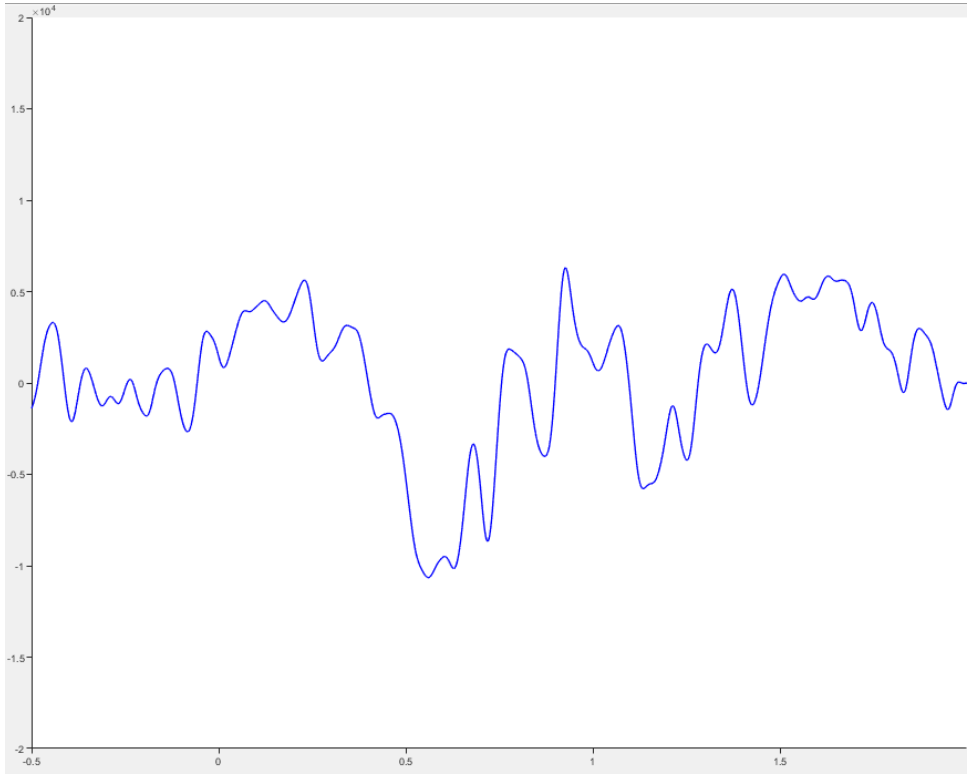
Select the channel and add the Color Legend. Save the map using Snipping tool.

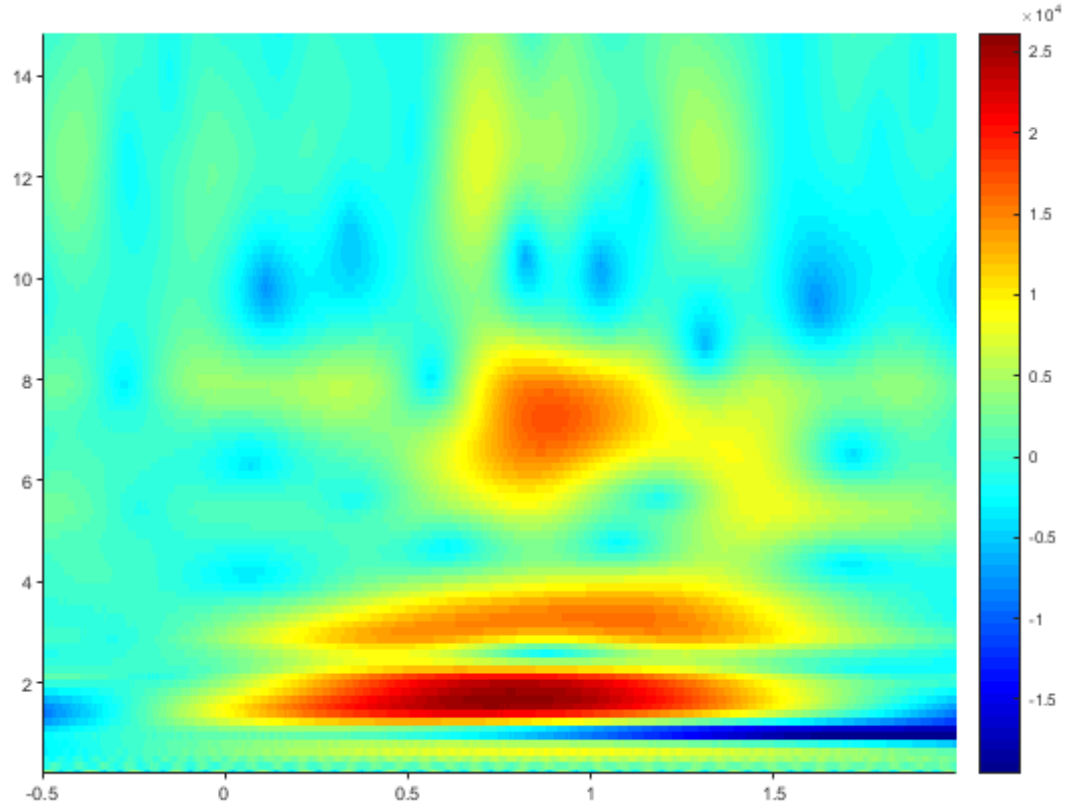


Template for reporting OERPs



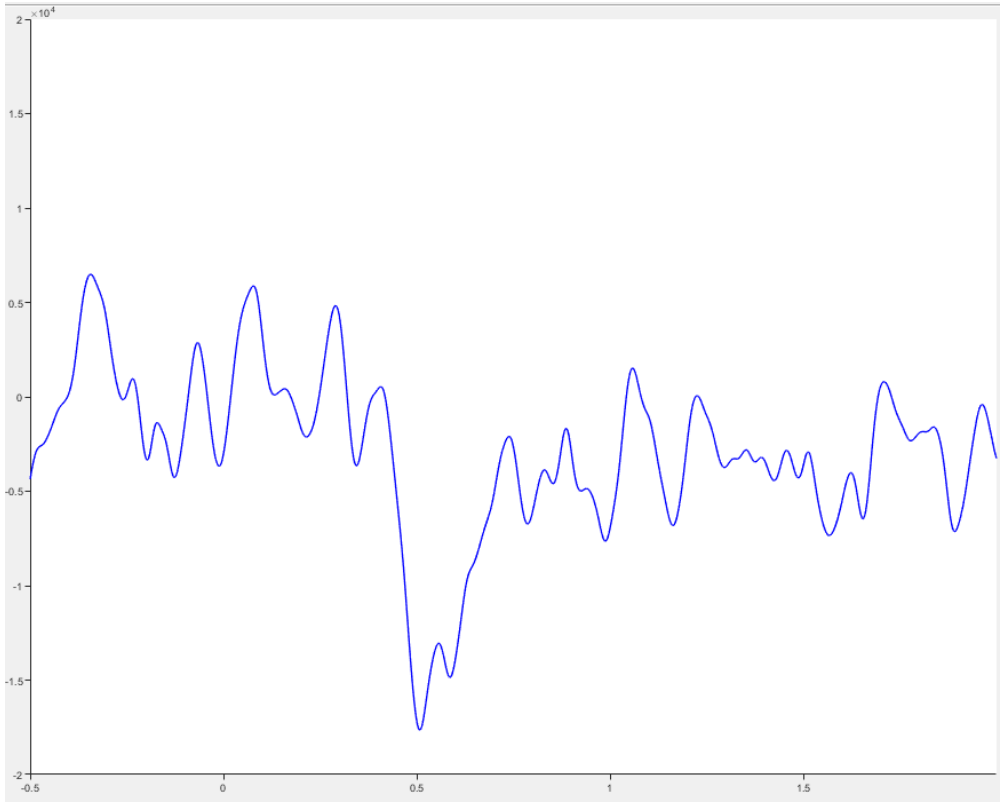
Examples of OERPs showing olfactory responses, together with time-frequency view

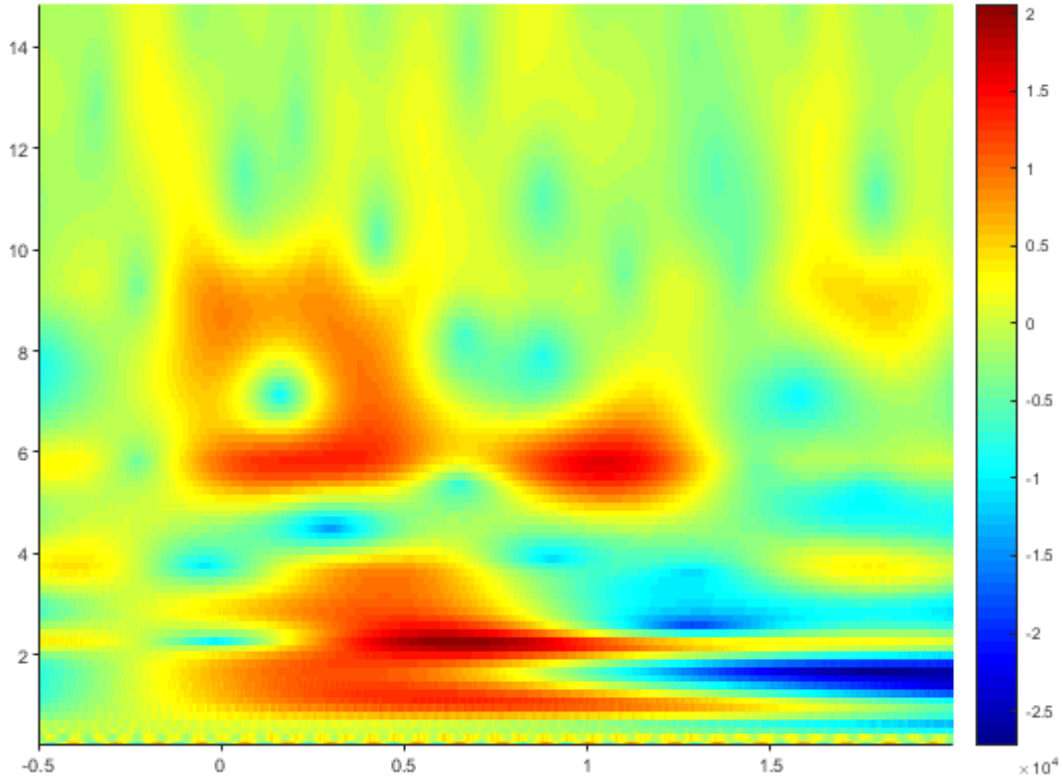




OERPs should be visible around 0.5s after stimulus onset. In TFA low frequencies should be present.

Examples of trigeminal ERPs showing trigeminal responses, together with time-frequency view





Trigeminal ERPs should be visible around 0.5s after stimulus onset. In TFA low frequencies should be present.